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Jolanta Mizera-Pietraszko
Pit Pichappan *Editors*

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Lecture Notes in Real-Time Intelligent Systems

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Preface

Real-time intelligence is concerned with the real-life data processing in digitized form which reflects "varied data-inclusive." Real-time intelligence speaks the real-life environment as well as perceptions and understanding derived from analytical processing. It draws data from the empirical settings and real life which enables the processing for real-life situations. Real-time processing depends on real-life data from internal and external environment and characterized by online data.

Realizing the value and significance of real-time intelligence, this current volume on "Lecture Notes in Real-Time Intelligent Systems" is planned and the issue is being published with 56 papers.

Based on the 2016 Beijing Conference on Real-Time Intelligent Systems, this special issue on *"Lecture Notes in the Real-Time Intelligent Systems"* is focused on a broad range of methodological concerns. It features 56 original papers addressing the topics ranging from fundamental questions related to theory and method to questions of applications. Together, these articles reflect the rich variety of intelligent data processing addressed by artificial intelligence researchers and the breadth and depth of theoretical, methodological, and practical approaches to be considered in real-time intelligence research.

These papers in this volume represent a significant contribution to the field. They make a strong connection between philosophical theories of truth and the practice of artificial intelligence researchers. They make a convincing case for the utility of the coherent distinction across the domain of artificial intelligence.

A total of 142 submissions was received, 56 of which were finally accepted for this volume. Each accepted paper has gone through two to three rounds of reviewing, each round with three to four referees.

We do hope that this special issue paves the way and sets the directions for the future research in the real-time intelligence domain.

Jolanta Mizera-Pietraszko
Pit Pichappan

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Applications of Artificial Intelligence

A Research on Classroom Teaching Ability System Construction of English Teachers Combined with Artificial Intelligence

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Abstract. With the rapid development of the computer technology, thousands of households have access to the Internet, which plays an increasingly important role in people's daily life. In the meantime, scientific and technological development has brought us many innovations, which produces new development opportunities to many traditional industries. English teaching has always been an important part of the teaching system. With the increase of international exchanges, English as an international language is frequently used, which poses higher requirements for the English teachers. It has become a hot subject of research currently to design an appropriate English teaching system and accomplish the English teaching tasks in an efficient way. In light of that, this paper first analyzes the research status of the English teaching system both at home and abroad, researches the features of English teaching and the construction principle of the teaching system, and explores the principle and application method of the artificial intelligence technology. Based on the research of relevant concepts and theoretical basis, this paper constructs a classroom teaching ability system of English teachers combined with artificial intelligence, explores the application effect of this system through specific teaching case design, conducts contrast experiment and proves the validity and advancement of this system through the analysis of experimental results, and demonstrates that the new teaching system is conducive to improve the teaching ability of the teachers and the English teaching quality.

Keywords: Multiple intelligence theory · Intelligent teaching · Teaching system

1 Introduction

An important feature of the contemporary society is the emphasis on the application and innovation of knowledge. In this era, the education industry is undergoing transformation to the basic, all-round and advanced knowledge industry. Relevant important infrastructure is being improved. Our country has also regarded education as one of her top priorities and attaches great importance to the development of the cause of education. Our institutions and the curricula play an important role in order to achieve educational reform. Under the circumstances of international integration and common development,

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foreign languages, English in particular, are widely used and it has also posed higher requirements on our level of English fluency. Therefore, English teaching has become an important part in the current teaching system, which has received more attention from the institutions, teachers and parents.

With the development of the Ethernet, informationization and the computer technology and the deepening of the concept of intelligence, a new type of technology, namely artificial intelligence, is being explored and utilized by people. The abbreviation of artificial intelligence is AI, which means to simulate human thinking by way of the computer and then to handle problems with similar human thinking and method. In other words, artificial intelligence is the frontier indicator of modern technology and is one of the hottest research topics in the current technological field. In light of this, this paper explores the theoretical basis and application method of the construction of English teaching system combined with the artificial technology and also blazes new trails to reform the English teaching system.

As for the issue put forward in this paper, researchers have done profound exploration and have received rewarding results. As for the cause of education, lifelong learning is an objective that we will strive for a whole life. We should be good at putting forward and resolving problems. In the face of complicated issues, we should be bold enough to query, to explore, to break professional barriers, and to cooperate share with other people so as to make common progress. More importantly, we should reflect on ourselves three times a day, to combine real situations with virtual reality, to make full use of all kinds of multimedia instruments like communications, the Internet and the computer, and to dig our own learning potential [1]. It is imperative that we conduct the reform in the English teaching. According to the deployment of the education department, English teaching should pay more attention to cultivate students' comprehensive capability to utilize languages and help students form an active learning attitude and good learning habits. The traditional teaching method focused on vocabulary and grammar is no longer applicable [2]. Howard Gardner, an American psychologist, holds that different students have different intellectual capabilities. Therefore, language teaching should not be the same for all students. Rather, it should start with the different features of different students and to teach students in accordance with their aptitude [3]. The sustainable development of our society and the arrival of the learning society pose an objective requirement on the elementary education to pay more attention to the need of lifelong learning of each student, to inspire the wishes of lifelong learning of every student, to guide the middle school students to think independently and plan their own lives, and to equip our students with basic professional consciousness, career consciousness and critical thinking capability [4]. Machine learning is based on statistics and information theory, which is the result of the analysis of the large amount of data and the conclusion and learning of human experience. When similar issues occur, the machine can resolve them based on experiential knowledge [5].

The second part of this paper introduces and analyzes the English teaching model and teaching system and researches into the relevant concepts and theories of artificial intelligence. The third part explores the possibility and construction method of the classroom teaching ability system of English teachers based on the previous theories. The fourth part conducts a practical experiment of the teaching system

designed in the third part. Through the contrastive comparison of the experimental results, it proves the feasibility and efficiency of this teaching method by applying the statistical method and it also demonstrates it is meaningful to research into this system. The fifth part is the conclusion of the whole paper and it also points out the deficiencies of this paper and points out the direction of further research.

2 Language Teaching Design

2.1 Foreign English Teaching Model

We have much to learn from the language teaching models in countries where English is their mother tongue. Based on different learning attitudes, there are several models of foreign English teaching which are shown as follows [6].

S. D. Krashen Model: this model mainly describes the learning process. Under circumstances where affective filter conditions are quite low, it can provide enough understandable input information and promote learning through a predictable sequential process.

E. Bialystok Model: this model mainly describes the forming process of the English language capability. Through the learning of general language knowledge, implied language knowledge and explicit language knowledge and numerous exercises, we can form the English language capability.

H. H. Stern Model: this model determines the inner relations between the five factors. The social background and learning conditions of the learner jointly determine the learning process. Different learning processes directly determine different learning results.

C. N. Candlin Model: this model combines three knowledge systems of language form, conceptual meaning and interpersonal relations. These three aspects are interwoven and inseparable and they altogether determine the process and results of English learning.

C. R. Hubbard Model: this model describes an interactive model of English learning. In an environment where objective matters exist, learners can conduct communications more freely and they can learn and speak in English in communication.

2.2 Domestic English Teaching Model

As English is our second language, the English teaching in domestic language teaching system is still at an exploratory stage. Different teaching systems keep emerging and their teaching effects and quality are different. The following are the major models [7].

Grammar translation model: this is a widely used teaching method and is the most fundamental one. Many schools and teachers have attempted to reform this model. However, its fundamentals remain unchanged with a major teaching process focused on teachers to introduce vocabulary, texts, the translation of the texts, the explanation of typical sentences with grammatical significance, and the conclusion of words and grammar and then the students' job is to practice.

Cognition model: this is a reformed version of the grammar translation model whose focus is the understanding of knowledge. Students should focus on understanding and form the language capability and learn to use this language based on their understanding of the text structure and contents.

Aural-oral model: this is a teaching model based on behavioral psychology and linguistic structural studies. After the explanation of the teachers, students can learn to imitate the teachers, and repeat, replace, and expand what they have learnt so as to communicate in this language.

Communicative model: this is a teaching model based on the theory of social linguistics. Its teaching process is that the teachers will teach and students will learn from them and practice and then they can deepen their understanding and application of the language through communication with others.

2.3 Artificial Intelligence Theory

Artificial intelligence is one of the hottest research directions at present. It is a branch of the computer science, which is deemed as one of the three cutting-edge technologies in the world. Artificial intelligence explores the nature of human intelligence and then apply the computer to imitate this human intelligence so that machine can have some features of human, can conduct human thinking and action, and can handle problems in ways similar to human [8].

At present, artificial neural network is one of the most widely used theories in the field of artificial intelligence. The theoretical basis of the research on artificial neural network is the theory of cerebral neuron. According to this theory, there are more than 10,000,000,000 neurons in human's cerebral cortex. They are interconnected to form a neural network, which can receive all kinds of information from the sensory ending and then transmit to the central nervous system. It can also analyze and process the information and then transmit the information to the motor ending to coordinate various functional activities of the body [9]. The research of the artificial neural network is to reflect some basic features of the functions of human brain and then to imitate, simplify and abstract it, rather than to get a vivid description of the whole biological system. Compared with general computer, the artificial neural network is much more similar to human brain in terms of the constitutional principle and functional features. It does not calculate step by step according to the given procedure. However, it can adapt to the environment, conclude the rules, complete certain calculations, recognize or control the whole process [10]. A typical artificial neuron is shown in Fig. 1 as follows.

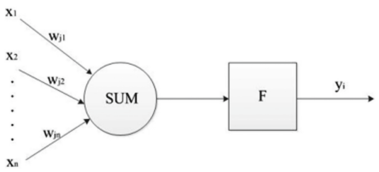

Fig. 1. Artificial neural

In general, when the i^{th} neuron has multiple input values $X_j (j = 1, 2, \ldots, m)$ and single output value Y_i, the formula is as follows:

$$I_i = \sum_{j=1}^{n} w_{ji} x_j - \theta_i \tag{1}$$

$$y_i = f(I_i) \tag{2}$$

In the above formula, θ_i is the threshold value, which can be preinstalled by people. W_{ji} is the weight coefficient from the j^{th} to the i^{th} neurons and f(I) is the transition function.

The neuron transition function: the transition function of the neuron determines its mathematical model and the information processing feature. Therefore, it is of great significance. Common neural network models include input-output model, effect function model, error calculation model and self-learning model [11].

Non-linear transition function is non-diminishing continuous function with a range of [0, 1]. The most typical one is the unipolar Sigmoid function curve or the S Function. This function is much easier to handle, because this function itself and its reciprocal are continuous [12]. The definition of the unipolar S Function is as follows:

$$f(x) = \frac{1}{1 + e^{-x}} \tag{3}$$

2.4 Gardiner Multiple Intelligence Theory

There are fundamental differences between traditional intelligence theory and multiple intelligence theory, which are demonstrated as follows:

Firstly, the traditional intelligence theory holds that the amount of IQ or intelligence of human is determined ever since his birth. However, the multiple intelligence theory holds that human have nine kinds of intelligence and the differences between different people lie in the degree and combining form of these nine kinds of intelligence [13].

Secondly, the traditional intelligence theory asserts that the intelligence of human is composed of linguistic capability and logic thinking. However, the multiple intelligence theory holds that the intelligence of human is multiple and it will generate different capabilities to resolve problems or produce products under different social and cultural background, which is the manifestation of intelligence. The multiple intelligence theory affirms the potential in the development of human beings.

Finally, the traditional intelligence theory holds that human's intelligence remains unchanged ever since his birth. However, the multiple intelligence theory holds that the evaluation of intelligence should be based on the different combining forms of intelligence in order to classify them because human intelligence is diversified. With proper guidance and encouragement, everyone can improve his intelligence to a relatively high level.

Based on the previous comparison, we can conclude that multiple intelligence theory places more emphasis on individual differences and is more customized in comparison with the traditional one. Therefore, it can truly reflect the nature of human intelligence.

3 Methodology

To get a better understanding of the English teaching system status currently, we conduct a field investigation of all the middle schools in this city to put forward a well-targeted teaching system reform plan. The statistics is made of the current English teaching system as follows (Table 1):

Table 1. The middle school English teaching system

Teaching mode	The classroom teaching	Computer teaching	The multimedia network teaching	Autonomous learning network platform
The implementation of school number	8	17	23	6

From the above investigation, we can see that most schools have started to change their teaching models rather than focus on the traditional classroom teaching. Teaching models with the assistance of computer and multimedia are widely acknowledged. Figure 2 demonstrates the teaching scenario with the aid of computer and multimedia in colleges and universities. From this, we can see that it is of great importance to optimize the English classroom teaching system based on informationization, combined with artificial intelligence technology, and guided by the multiple intelligence theory.

Fig. 2. Computer multimedia teaching scenario

3.1 Principle of the English Teaching Ability System

Based on the research into the English teaching models both at home and abroad and the multiple intelligence theory, we conclude the basic principles of the new type of English classroom teaching ability system to be constructed as follows:

1. Openness: the teaching purpose is not only to impart knowledge, but also to cultivate students' emotions. The grades are not the single standard of the evaluation of the teaching results and we should combine the teaching process and self-evaluation and the evaluation of others. The teaching methods are more open and take different forms for different students according to their aptitude.

2. Differentiation: the methods for different students should be different. As different students have different types of intelligence and different capabilities, teaching should not be all the same for every student. However, teaching plan should be more customized to different student so as to guide every student to give full play to their potential.
3. Independence: students should be the subject of learning and teachers should only guide and inspire them to learn. More time and opportunities should be given to students to learn independently, to communication and to make full use of their enthusiasm.

3.2 Basic Framework of the English Teaching Ability System

As is shown in the above picture, the new English teaching ability system is based on the multiple intelligence theory. The major carriers of teaching are music, visual spaces, interpersonal relations and body movement. In light of this, the new English teaching ability system to be constructed can realize the purpose of promoting the development of students and improving students' comprehensive English capability (Fig. 3).

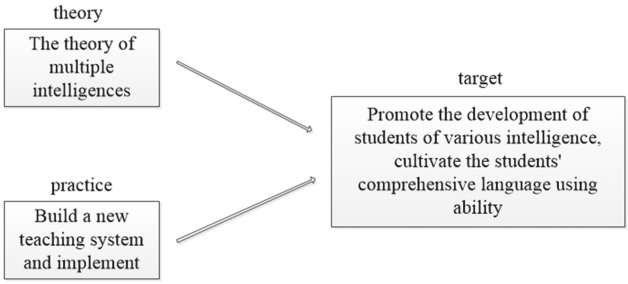

Fig. 3. Computer multimedia teaching scenario

3.3 Running Program of the English Teaching Ability System

First of all, teachers should introduce the classroom teaching in a brand-new and interesting way and create a relaxing linguistic environment to better inspire students' learning interest and initiative. Secondly, teachers should combine the multiple intelligence theory to fully stimulate students' senses of sight, hearing and listening and to motivate students to be completely integrated in the teaching process. Finally, teachers can introduce various teaching carriers like music, sports activities and fine arts to help students practice and strengthen their capability of English application and improve their comprehensive linguistic capability.

4 Data Analysis and Discussion

According to the previous research, we design and construct a new English teaching ability system combined with the multiple intelligence theory and conduct a contrast

experiment between this system and the traditional English teaching system. In this experiment, we randomly choose 100 secondary school students from a certain school and divide them into two groups with each group being 50 students. We apply the new English teaching ability system combined with the multiple intelligence theory to teach the experimental group and the traditional English teaching system to teach the comparison group. After the experiment, we organize a test for the two groups of students and compare their grades. In the meanwhile, we conduct a questionnaire to the students from the experimental group to know the changes brought by the new English teaching ability system combined with the multiple intelligence theory in their English learning. Relevant data are shown as follows:

According to Table 2 and Fig. 4, we can see that the overall grades of the students form the experimental group are higher than those of students from the comparison group. For the experimental group, there are more students having a high grades and less students having a low grades and their teaching quality is much higher. From Table 3 and Fig. 5, we can see that students from the experimental group have improved their interest in learning English after receiving the new English teaching method. Form this we can conclude that the new English teaching ability system combined with multiple intelligence theory is much more effective than the traditional system and is of great importance in improving students' interest and initiative in the learning of English. It also demonstrates the correctness and advancement of this system and that this system deserves to be further promoted.

Table 2. Two groups of student performance statistics

	More than 90	80~89	70~79	60~69	Below 60
The experimental group	10	12	16	11	1
The control group	8	10	14	13	5

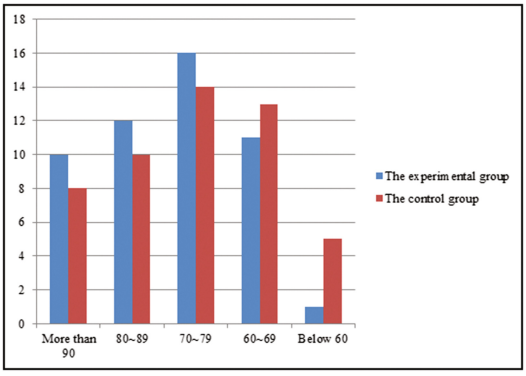

Fig. 4. Two groups of student performance statistics

Table 3. The experimental group students' English learning interest

	Very interested	General	Not interested	A combined
Listen to the teacher before	20	18	12	50
After listening to lectures	26	21	3	50

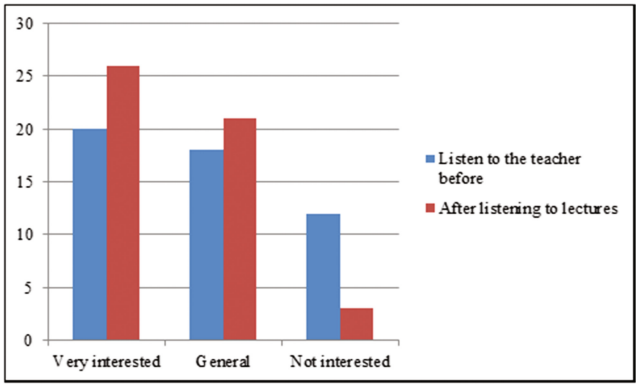

Fig. 5. The experimental group students' English learning interest

5 Conclusion

In recent years, with the rapid development of our economy, people's material life has been significantly improved. Therefore, people are paying more attention to their spiritual and cultural needs. Education is an important guarantee to improve the quality of life and satisfy people's spiritual and cultural demands. As the economic globalization is gaining momentum, our definition of talents is changing and demands for talents are increasing. The traditional teaching model can hardly satisfy the need of our times. For the reform of the cause of education, it is imperative to develop quality education, especially the teaching of English, which is a course our schools, parents and students have attached great importance to. It has become a widely concerned issue to reform the existing English teaching system, improve the teaching quality of English, and cultivate students' comprehensive ability in using English. The rapid development of computer and the Internet technology has brought us infinite possibilities. Many high-grade, precision and advanced technologies such as artificial intelligence technology and virtual reality technology have been introduced into our daily life and work, which has provided an opportunity for the reform of the cause of education. They enable the combination of artificial intelligence technology and English teaching and make it possible to construct a more intelligent and optimized English teaching system.

Through the research in this paper, we can make the following conclusions. Under the environment of reform and development of education, the traditional English teaching model cannot satisfy the teaching demands of our schools and the learning

requirements of our students for knowledge acquisition and capability cultivation. The domestic English teaching models are still at an initial stage with a focus on vocabulary, grammar and translation. Although we have introduced many new media like computer and multimedia, the teaching effect is still not perfect. The multiple intelligence theory emphasizes the differences of teaching and the importance of teaching each student according to their aptitude and inspires the learning interest and initiative of every student. The students should be the subject of learning, while teachers should assist and guide them to improve their comprehensive English application ability [14, 15].

Although some results have been achieved in this paper, there are still some deficiencies. For example, the experimental sample is too small and the experiment duration is not long enough. Therefore, we should continuously deepen our research, expand the scope of research, and optimize the design of the English teaching system so as to make this teaching system to cover multiple disciplines in the upcoming researches.

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Study of the Establishment of a Reliable English-Chinese Machine Translation System Based on Artificial Intelligence

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Abstract. Since twenty-first Century, more and more communication among different countries has made the need for the language translation of the enterprises and individuals more and more. Artificial translation is accurate, but the cost is too high and time-consuming; while the cost of the machine translation is not only low, but the speed is fast. However, the accuracy of machine translation has been criticized by users, therefore, how to build a new generation of machine translation system to improve the accuracy has been imminent. Based on this, a reliable English-Chinese machine translation system based on artificial intelligence is established in this paper, and the principles that should be followed in the process of establishing the system are described in detail, the overall framework, the translation algorithm and the working flow of the system are discussed, and the sentence alignment method based on the translation is proposed. The research results show that the reliable English-Chinese machine translation system based on artificial intelligence designed in this paper can improve the credibility and accuracy of machine translation.

Keywords: Artificial intelligence · Reliability · English-Chinese machine translation · Translation algorithm

1 Introduction

As a cross discipline, machine translation is a high degree of knowledge intensive technology, which needs to be completed by the linguists and computing technology experts [1]. There are still not perfect places in the research and development of the machine translation, but the request of the users is very high, its accuracy needs to be as perfect as the operation [2]. However, even if the computer can help people to complete some intelligent activities, such as computing, but the ability of intelligent translation is different from the operation in essence [3]. The regularity of the operation is strong, the technical staff can sum up the rules to use the computers to simulate the process [4]. The characteristics of the translation work are that the normalization is weak, and its process is difficult to be simulated [5]. So far, the study of the mechanism and the way of the

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brain processing language has been still very little, so machine translation effect has been still not satisfactory, especially the translation of complex sentences and texts [6]. Therefore, it is scientific and practical to build a trusted English-Chinese machine translation system based on artificial intelligence [7].

2 Background

After the advent of the first electronic computer [8], in 1947, engineer Weaver officially proposed the concept of machine translation in his book "Translation", in the decades after that, machine translation has also experienced a tortuous process of development. In 1954, the first machine translation system was proposed, which proved the feasibility of the machine translation system to the world [9]. In 1966, the ALPAC report proposed that it was unnecessary to add more investment to the MT (Transfer System Machine) [10]. The low tide period of machine translation system research was coming [11]. From 1975 to 1989, the second generation of the machine translation systems have been actively developed [12]. This generation of machine translation system has combined many technologies, such as knowledge and separation algorithms, modular design, syntax analysis and semantic analysis of a variety of strategies, and most of them have applied artificial intelligence technology. After 1989, the third generation of machine translation system was born and developed rapidly, this generation of translation system was both based on statistics and based on the actual case, and combined with the advantages of the former two generations of machine translation.

In twenty-first Century, machine translation system also should progress with the times, therefore, this paper presents a reliable English-Chinese machine translation system based on artificial intelligence. In the third section, the established principles, the overall framework, the translation algorithm, the work flow and the automatic alignment method of the bilingual sentences of the machine translation system based on the artificial intelligence are introduced; In the fourth section, the performance of the English-Chinese machine translation system based on artificial intelligence is analyzed, and finally the conclusion is made (as shown in Fig. 1).

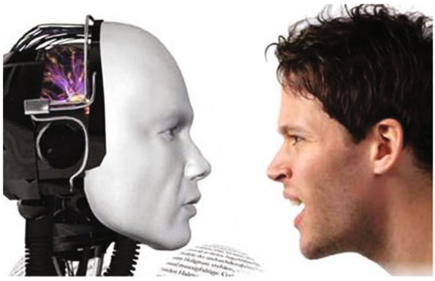

Fig. 1. English-Chinese machine translation system based on artificial intelligence and reliability degree

3 Methods

3.1 Principles of the Establishment of the English-Chinese Machine Translation System Based on Artificial Intelligence

It is a very difficult project to build a reliable English-Chinese machine translation system based on artificial intelligence, which not only needs to guarantee the intelligence of the system, but also maintain the credibility of the system. The following important principles are adopted in the establishment of this system.

Data and procedures are independent of each other: the dictionary used by the machine and the system data of the rules is represented separately in the form of a database file on separate disks, and independent of the translation program, this is not only conducive to data management, maintenance, update, but also conducive to the upgrading and expansion of the translation process. From the point of view of the process control mechanism, "control" and "implementation" are two different mechanisms, the execution mechanism is responsible for the data analysis and operation, and the control mechanism is responsible for the control of the whole system at a higher level. The improvement of the control mechanism will improve the execution mechanism, but will not affect the logical performance of the execution mechanism, and the change of the implementation mechanism will not fundamentally affect the control mechanism, because the control mechanism is only implemented in the underlying implementation mechanism.

Designing a more specialized machine dictionary: in order to improve the quality and efficiency of the English-Chinese machine translation system based on artificial intelligence. The form of "the basic entry professional entry" is used in this system. The literary translation of professional fields is based on dictionary translation and professional entry. Such as the literary translation of the automatic control technology, the dictionary only needs to have basic entry and computer professional entry, when the professional field is changed, it only needs to change a part of the professional items, and maintain the basic items. The dictionary with this structure not only has the inheritance, but also can be removed and replaced, which is conducive to the expansion and improvement of the dictionary.

Paying attention to the order and classification rules of translation: The English-Chinese machine translation system based on the artificial intelligence not only needs to have a suitable machine dictionary, but also needs the appropriate rules, and follows the principles of the first special after the general. The English-Chinese machine translation system based on artificial intelligence should carry on the scientific classification on the basis of the principles of syntax analysis and semantic analysis.

3.2 Overall Framework Design of the English-Chinese Machine Translation System Based on Artificial Intelligence

The framework of an English-Chinese machine translation system based on artificial intelligence can be roughly divided into the following three parts (as shown in Fig. 2).

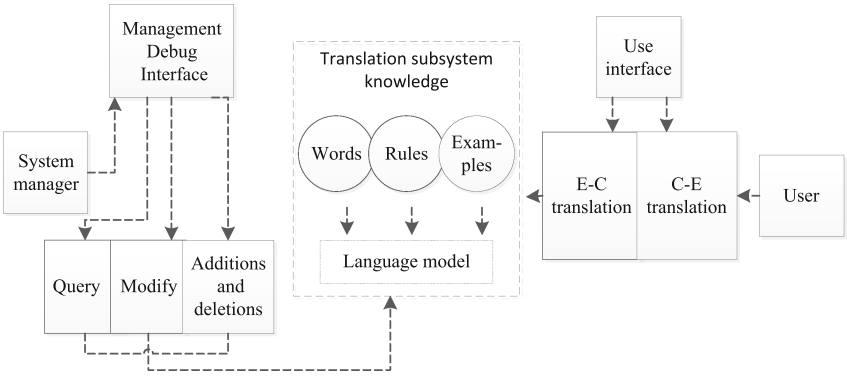

Fig. 2. The framework of the English-Chinese MT System

Translation system knowledge base: the translation process of the English-Chinese machine translation system based on artificial intelligence can be regarded as an application and knowledge of the process of reasoning. Knowledge representation is the basis of this process, and the knowledge representation methods used in the English-Chinese machine translation system based on artificial intelligence is divided into two categories: internal and external knowledge. The external knowledge is stored in the knowledge base, which is managed by the language knowledge, researchers, such as the dictionary and all kinds of rules. The internal knowledge is the sentence to describe the syntax and semantic features of knowledge in the process of translating, such as the tree graph, the structural feature and the semantic network. The knowledge base of the translation system includes a language model, a dictionary, a lot of rule bases and a case base. The dictionary is divided into basic bilingual dictionaries and bilingual dictionaries. Rule base stores the phrase rules, sentence patterns, sentence pattern matching rules, English-Chinese translation rules, and so on; All the rules have the same data structure. Case library stores the English-Chinese bilingual examples and related information.

Part of the processing system: English word processing includes English automatic segmentation and fuzzy word processing, this part is the basis of the combination of phrases and sentence matching, which automatically uses the maximum matching word segmentation algorithm, the system uses the rules and statistical methods to eliminate and merge. In the English analysis part, there are two parts in the system, the combination of phrases, and the sentence matching. The task of phrase merging is to use a variety of phrase rules and methods to divide the class words into five basic phrases, the sentence matching is based on the combination of phrases. In the Chinese- English translation and the Chinese generation part, there are three levels of transformation and generation, including words, phrases and sentences, the tasks and algorithms of each layer are different.

Operation interface: interface includes user interface and administrator management debug interface. For an actual machine translation system, debugging language rules and dictionaries are very important. In the debugged good machine translation system management interface, the system administrator can conveniently and intuitively debug the language rules and dictionaries, this can improve the efficiency of debugging,

improve the quality of the language knowledge base. The management and debugging interface of the English-Chinese machine translation system based on the artificial intelligence is responsible for the maintenance of the knowledge base management and translation and debugging. Knowledge base management function helps the system administrator to create and manage each knowledge base and inquire the debugging operation. For example, the system administrator can carry out debugging through the observation of the specific examples of the translation process of the language knowledge base. The system administrator can manage the production process of any syntax component and the characteristics of the corresponding node attributes and values.

3.3 Translation Algorithm and Work Flow of the English-Chinese Machine Translation System Based on the Artificial Intelligence

People often solve the new sentence through the past learning experience of learning a language, based on this idea, the examples from the corpus can be used to translate new sentences, that is to say, the experience of the past can be aroused by imitating human analogical thinking, and the grammatical structure, the semantic choice and the current translation of the target language are obtained. The translation algorithm of the English-Chinese machine translation system based on the artificial intelligence is based on the

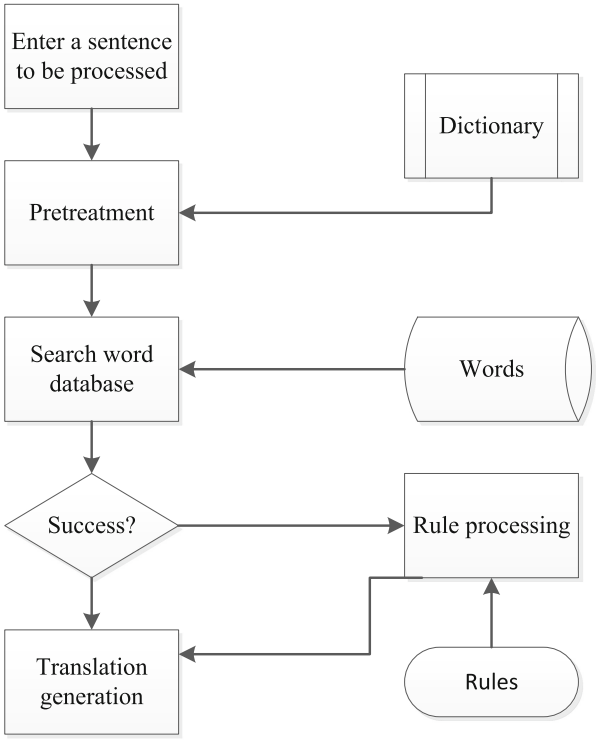

Fig. 3. General procedure of MT System

corpus as a priority, which is the rule of the auxiliary translation throughout. For each sentence, first the pretreatment is carried out, the most similar sentences and phrases in corpus based translation template are found out, if the size of the corpus is not large enough, then the translation is achieved by the rules concluded by the linguists, including the segmentation rules, the rules of the merger, the phrase rules, and the target language rules and so on. The translation process of the trusted English-Chinese machine translation system based on the artificial intelligence is shown in Fig. 3.

Among them, the translation method is based on the principle of conversion, follows the edge analysis, and simultaneously generates the design principles. The specific translation algorithm is shown in Fig. 4.

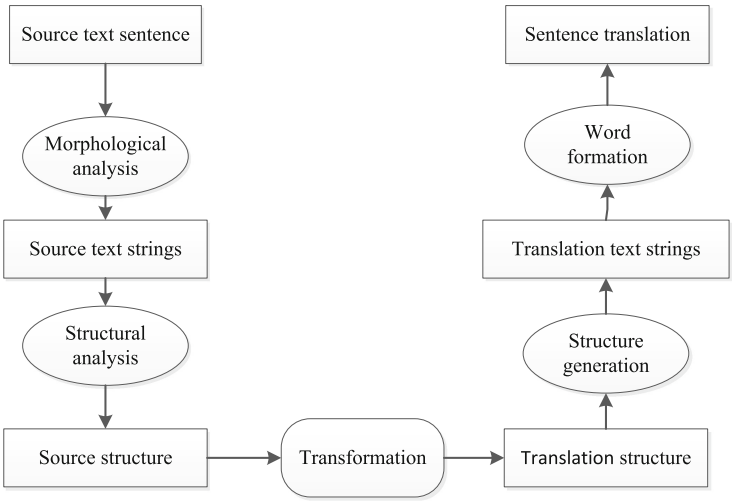

Fig. 4. Procedure on MT System based on rules

Text files, keyboard input and scan input of the three ways can be used to input the original text.

The English morpheme analysis stage is divided into overlapping word processing and segmentation of the two steps, English word segmentation uses the bidirectional maximum matching algorithm. The rule base is used to eliminate ambiguity in the processing of the text word segmentation, when a word segmentation ambiguity occurs, it is unnecessary to make a judgment, it is needed to be maintained to the structural analysis phase to be processed. If there are no disambiguation rules, the Chart Parsing algorithm can be used to transfer the default phase structure, phase analysis adopts a top-down and local sub tree structure generation, phase transformation algorithm uses the method of the combination of partial sub tree transform algorithm and top-down global sub tree displacement algorithm.

3.4 Automatic Alignment Method for Bilingual Sentences in the English-Chinese Machine Translation System Based on the Artificial Intelligence

In the existing machine translation systems, the applications of statistics and case method are more and more extensive, and the bilingual corpus is more and more important. The bilingual corpus has a variety of forms, such as text level, sentence level and lexical level. It is very easy to get to the level of text, but not very useful. Automatic translation of bilingual texts from the textual level is a process of automatic translation and alignment of bilingual sentences, it can further find the relationship between the corresponding vocabulary, and obtain the basis of other translation knowledge.

A large number of studies have been made on the translation by the foreign scholars in India and Europe, and a good result has been achieved. Their approach is summed up in two ways: Based on the length and alignment method, and based on the word alignment method. But there is a big difference between Chinese and India, although these methods can also be used directly, but the effect is not obvious. And due to changes in the language environment, the use of these methods is also a lot of restrictions. On this basis, Wang Bin proposed a sentence alignment method based on comprehensive information, but the accuracy is not high.

Therefore, the establishment of the English-Chinese machine translation system based on the artificial intelligence needs to propose a new alignment method. In this paper, a new method is proposed, which is based on the translation method. The specific contents are as follows:

The formal representation of sentence alignment is: sentence alignment is to regard the translation of a sentence as a sentence with two languages together, and its formal representation is: Setting M and P are the translation the target text of each other, and can be expressed as a combination of sentences, namely, $M = m_1 m_2 \ldots m_n$, $P = p_1 p_2 \ldots p_n$. The Setting U is the minimum alignment of S and T, it consists of x sentences $m_{i1}, \ldots, m_{i+x-1}$ in M and y sentence $p_{i1}, \ldots, p_{i+x-1}$ in P. So the alignment of M and P can be expressed as a sequence of all U: $u_1 u_2 \ldots u_k$, the task of $U_i (i = 1 \sim i)$ is to find a minimum alignment sequence.

Based on the translation of the English-Chinese bilingual sentence alignment. The choice of word evaluation function is based on the choice of the translation of sentence alignment method, which involves not only the English sentences, but also the Chinese sentences. In addition, in order to reduce the influence of the dictionary on alignment accuracy, the part of speech tagging and additional processing are not introduced. As long as there is a translation and Chinese-English sentence in a string matching, it is considered that the English word is the translation in Chinese sentences. This is because in most cases, although the nature of the English words is different, but its meanings in Chinese are similar, but which are not always included in the dictionary.

For the dynamic programming algorithm and overall evaluation function, the dynamic programming algorithm is used in this paper in the process of choosing alignment. The Setting E_1 is the number of sentences in the English segment, and E_2 is the number of sentences in the Chinese segment. The value of each possible sentence in the English and Chinese texts is evaluated, according to the consideration of this article, including:

The number of evaluation values of 1:1 is:

$$E_1 * E_2 \tag{1}$$

The number of evaluation values of 1:0 is:

$$E_1 * (E_2 + 1) \tag{2}$$

The number of evaluation values of 0:1 is:

$$(E_1 + 1) * E_2 \tag{3}$$

The number of evaluation values of 2:1 is:

$$(E_1 - 1) * E_2 \tag{4}$$

The number of evaluation values of 1:2 is:

$$E_1 * (E_2 - 1) \tag{5}$$

The number of evaluation values of 2:2 is:

$$(E_1 - 1) * (E_2 - 1) \tag{6}$$

Therefore, the sum of the values of the total is the sum of the values above, namely, $B = 6 * (E_1 * E_2) - E_1 - E_2 + 1$, according to this value, the dynamic programming algorithm is used, the opposite of the output is in the path of the word, that is the segment of the aligned sentence. In the specific process of solving, the node is the best path from start to the current node, the predecessor value of the node is evaluated, and the two values are used to select the best path. The tag in the path includes the alignment of the string. The overall evaluation function value of each path is the value of the review and the path of all alignments.

According to this value, the dynamic programming algorithm is used to find the path of the sentence which is the largest of the total evaluation value from the beginning to the end of the paragraph. In the process of solving the specific problem, the node from the starting point to the current node is first obtained, and the weight of the optimal path is recorded, then, the evaluation value of the start node is obtained, and the two values are used to select the optimal path. The marks on the path make up the alignment of the sentences on the string. The value of the overall evaluation function of each path is the value of the evaluation of all alignment sentences on the path.

4 Analysis

For the establishment of the English-Chinese machine translation system based on the artificial intelligence, the automatic alignment method of bilingual sentences and the accuracy of the system is very important for the whole system. Based on the above mentioned bilingual alignment method based on translation, this section conducts

experiments to test the accuracy and reliability of the English-Chinese machine translation system based on the artificial intelligence. Six forms are considered in the experiment: 1:1, 1:0, 0:1, 2:1, 1:2, 2:2, before the experiment, the English and Chinese texts are carried out preprocessing, and are divided into the form of a sentence. The whole alignment results are summarized in Table 1.

Table 1. The experiment results of the experimental group

Matching form	Number of aligned sentences	Correct number	Correct rate
1:1	1988	1982	99.7%
1:2	93	84	90.3%
2:1	172	166	
2:2	16	2	12.5%
1:0	0		
0:1	0		

From the above table, it can be seen that the sentence alignment method based on the translation fundamentally eliminates the mistakes caused by text spread in the text in the based method for length. In addition, the method doesn't involve the issue of training text, it is a test.

In addition, we carried out the same experiment with ordinary machine translation system, the experimental results are shown in Table 2, the comparison of the two groups is shown in Fig. 5.

Table 2. The experiment results of the control group

Matching form	Number of aligned sentences	Correct number	Correct rate
1:1	1988	1766	88.8%
1:2	93	67	72.0%
2:1	172	142	77.3%
2:2	16	1	6.3%
1:0	0		
0:1	0		

From the above experimental results, it can be seen that, for the 1:1 form, the accuracy of the translation of the English-Chinese machine translation systems based on artificial intelligence designed in this paper increases from 88.8% to 99.7%; for the 1:0 form, which increases from 72% to 90.3%; for the 0:1 form, which increases from 72% to 90.3%; for the 2:1 form, which increases from 72% to 90.3%; Thus it can be obtained that the accuracy of the translation of the English-Chinese machine translation systems based on artificial intelligence is significantly higher than the ordinary machine translation, which progress confirms the feasibility and the scientific nature of this machine translation system based on the artificial intelligence.

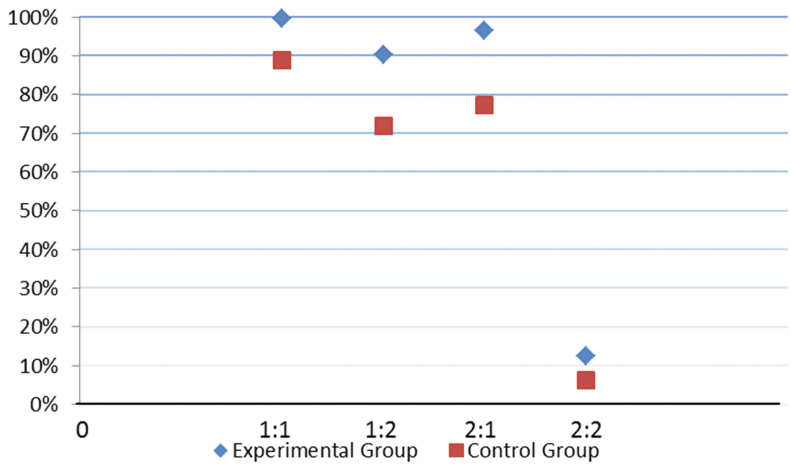

Fig. 5. Comparison of experimental results

5 Conclusions

In order to further improve the scientific and the accuracy of the machine translation, so that machine translation can better provide users with more accurate services. Based on the literature review and dynamic programming and other methods, a kind of reliable English-Chinese machine translation system based on artificial intelligence is established in this paper, and the principles that should be followed in the process of establishing the system are described in detail, the overall framework, the translation algorithm and the working flow of the system are discussed.

The research results show that the reliable English-Chinese machine translation system based on artificial intelligence successfully combines many features of the previous machine translation systems, and on this basis, it is further upgraded. The key point is that the new sentence alignment method is put forward, which is the automatic alignment method based on the target text, the experiment proves the feasibility and accuracy of this method and the translation system. However, the research on semantic analysis and translation of web pages is still not perfect, it is needed to pay more efforts.

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Analysis on the Application of Artificial Intelligence Technology in the Construction of the Internet Interactive Platform of Inquiry Curriculum

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Abstract. With the rapid development of computer technology, artificial intelligence technology and the Internet are playing an increasingly important role in people's survival and development. Learning is dependent on the environment, which means that the learning style in the new technological environment will undergo new changes. Therefore, it has become a hot research subject to combine the artificial intelligence technology with the construction of the inquiry-based Internet interactive platform to reform the existing teaching methods. During the research, the research status of the Internet inquiry learning both at home and abroad is analyzed and relevant theme websites are investigated. Then this paper probes into the relevant concepts and theoretical basis of artificial intelligence and the inquiry-based Internet interactive platform. Next this paper explores the application of artificial intelligence technology in the construction of the Internet interactive platform of inquiry curriculum through specific case designs and conducts practical experiments. Finally this paper, through the contrastive analysis of the experimental result, demonstrates the correctness and advancement of this idea and proves that this new idea will enable people to have more desire to communicate with others and that their learning capability on all respects can be improved.

Keywords: Artificial intelligence · Inquiry education · Internet interactive platform

1 Introduction

One important characteristics of the current age is the emphasis on the application and innovation of knowledge. In such an era, the education industry is undergoing gradual transformation to fundamental, all-round, and advanced knowledge industry. The important infrastructure of the education industry is being improved. The state has attached special importance to education and has vigorously promoted the development of the education industry. To achieve the educational reform, both schools and curriculum arrangements play an important role to bridge what is desired and the reality. With the development and popularity of advanced technologies, such as the Ethernet,

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informationization and artificial intelligence, the modernization and technicalization of the education industry is gaining momentum. Students can acquire more knowledge in a comprehensive way. They should not only learn the theoretical thoughts put forward by our ancestors, but also explore the forming process of these theories and gain an in-depth interpretation of these theories. In the meantime, students can also make full use of the assistance and guidance of teachers, explore the subjects to their own interest, and learn to apply scientific way to research new subjects. Through such practice, students can cultivate a scientific attitude and a scientific method so as to make preparations for further study in higher institutions. In light of this, the construction of the Internet interactive platform of inquiry curriculum combined with artificial intelligence technology is becoming a focus of attention for researchers.

As for the issue raised in this paper, many research scholars have made an in-depth exploration of this phenomenon and have yielded remarkable results. As for the network problem exploration model, just as its name implies, investigation is in the way of guiding direction. In classes, teachers will assign a hypothetic task to the students. In general, this task is a question or a program to be answered or completed by the students. Meanwhile, teachers will provide some resources on the Ethernet that may be useful in the completion of the task. The students' task is to choose, analyze and organize these resources for their own programs [1]. According to an article published in *Beijing Youth Daily* under the title of "Colorful Online Life for Middle School Students", the author of this article conducted a survey. Through the survey, we find that, among all the Internet users of the middle school students, 60.7% of them like playing games, 34.1% of them like chatting with others, 29.1% of them like movies and television programs, 27.9% of them like sports, 27.5% of them like news, 18.6% of them use the Internet to work, and 5.7% of them pay more attention to medical and health information. We can infer from the above figures that the major purposes of surfing the Internet for middle school students are playing games, amusement, chatting with friends and sending E-mail [2]. We will strive for the cause of education and lifelong learning which should be the major objective. We will learn for our entire life. We should be adept in proposing and resolving problems. In face of complicated events, we should dare to question, explore, and destroy professional barriers. We should also learn to cooperate and share with other people so as to achieve common progress. What is more, we should reflect on ourselves three times a day and combine reality with imitated context, make full use of multimedia instruments, such as various communications, the Internet and computer, and give full play to our own learning potential [3]. The design of the Internet interactive platform of inquiry curriculum is to improve the students' awareness of independent study and cultivate students' independent study capability and their scientific quality. This platform is loaded with abundant scientific contents. Teachers can conduct individualized teaching according to different students. Students will have more learning styles. Other than traditional books, video clips and images will be added to the learning process and students will also have opportunities of practice [4]. With the sustainable development of our society and the advent of a learning society, the elementary education in China is required to pay more attention to the need of lifelong development of every student, inspire every student to pursue lifelong learning, guide numerous middle school students to think independently and plan their own lives, and equip every student

with basic professional consciousness, career consciousness and capability of critical thinking [5].

2 Materials and Methods

2.1 Artificial Intelligence Technology and Wavelet Neutral Network

Artificial intelligence technology is a discipline that is widely researched and applied. It is a kind of exploration and extension of human intelligence. It can also enable the computer to have the analytical and learning capability of human [6]. Artificial intelligence is an important branch of the computer sciences. Its theory is to explore the nature of intelligence and then we can create a machine with approximate human intelligence based on this theory to do highly intensive thinking activity on behalf of human. Its major research field includes intelligent robots, speech recognition, image recognition, natural language processing, expert system and other aspects [7]. Nowadays the development of artificial intelligence technology has gone a long way and its theoretical basis and operational technology have been much improved. With the popularity of artificial intelligence technology, we can imagine that the products of artificial intelligence technology will prevail in our daily life in the future. Artificial intelligence technology is by no means the same as human intelligence. It can only simulate human consciousness and thinking process. Although it cannot match with human intelligence at present, its future development is still uncertain and may exceed our expectations. The application of artificial intelligence technology in our daily life is shown in Fig. 1.

Fig. 1. Restaurant waiter

Wavelet neural network is based on the theoretical foundation of wavelet analysis and is an implementation model of wavelet transform. Its nature is a partial primary function network composed of wavelet functions according to resolution dimension stretch and translation of spatial position [8]. The wavelet function is a cluster of functions formed through translation and stretch of the primary function $\psi \in L^2$ and is shown in Formula 1 as follows:

$$\psi_{ab}(x) = |a|^2 \psi(\frac{x-b}{b}) \tag{1}$$

In the above formula, a and b represent the stretch and translation parameters. Its output is shown in Formula 2.

$$f(X) = \sum_{i=0}^{N} w_i \psi \left[\frac{X - b_i}{a_i} \right] \tag{2}$$

In this Formula, $X = [x_1,\ldots,x_i,\ldots]$ is the input vector, a_i and b_i are the stretch and translation parameters of the i^{st} input.

2.2 Curriculum Resources

The concept of curriculum resources is that any curriculum reform needs the support of curriculum resources [9]. Broadly speaking, any factors conducive to realize the curriculum objectives are curriculum resources. In the narrow sense, factors directly connected to the formation of curriculum are curriculum resources. Although there are various types of educational resources at our disposal in classroom teaching, we should be clear about one point that not all resources are curriculum resources. Only those that are used in classroom teaching and are closely related with teaching are called curriculum resources. The most important link in the smooth realization of the curriculum objective is the reasonable development and efficient utilization of those abundant curriculum resources, which is also an important link in the curriculum reform [10].

The characteristics of curriculum resources are as follows: potentiality, uncertainty, diversity, dynamic nature, concreteness and multi isotropy.

The classification of curriculum resources are as follows: curriculum resources can be classified into material resources and conditional resources according to their functional characteristics. They can be classified into campus curriculum resources and off-campus curriculum resources according to their spatial distribution. They can also be classified into campus curriculum resources, social curriculum resources and online curriculum resources according to their scope [11].

2.3 Scientific Inquiry

The scientific inquiry in scientific curriculum mainly contains three folds of meanings. Firstly, its primary purpose is to help students master learning methods and understand scientific knowledge. It cultivates the students' capability in independent learning and spotting and resolving problems. During this process, students will improve themselves in their emotional attitude and values. Secondly, scientific inquiry is also the training of learning contents. In general, knowledge includes statement knowledge and procedural knowledge. Scientific inquiry is a kind of procedural knowledge. It requires us to explore natural phenomena and the characteristics of things and to understand natural changes through scientific ways, such as observation, analysis, hypothesis, experiment and other ways. In scientific classes, students can learn how to conduct scientific inquiry and practice scientific inquiry methods. Thirdly, scientific inquiry is a kind of spirit. It is under such kind of spirit that those researchers striving for the cause of science are constantly exploring the unknown world and seeking the nature of our nature. Therefore,

students should learn this spirit since their childhood and learn all the contents of the whole scientific curricula.

2.4 Design Thought

Firstly, define and analyze the contents and scope of curriculum. Through information retrieval, the concept of curriculum resources is defined as the sum of all available human resources, materials and natural resources in the whole teaching process, including curriculum design, implementation and evaluation. The curriculum teaching objective is embodied in three aspects of knowledge and skills, process and methods, and emotion, attitude and values.

Secondly, collect, choose and process curriculum resources. Curriculum resources can be collected via multiple channels, such as textbooks, reference books, relevant periodicals and magazines and the Internet. The choice of curriculum resources should adhere to the principles of priority, adaptation, and scientific nature. The processing of curriculum resources renders them into three categories, namely teaching resources, self-study resources, and inquiry-based resources.

Thirdly, determine the objective of the construction of the inquiry-based Internet interactive platform. The basic conditions for an excellent learning website are as follows: a rigid structure and user-friendly interface, scientific contents, clear teaching objectives and teaching strategies corresponding to the teaching objectives, two-way exchanges with the learners and timely feedback.

Finally, determine the whole result of the inquiry-based Internet interactive platform and the function declaration of major columns. The whole structure of the interactive platform is shown in Fig. 2.

Major columns: The first one is subject introduction whose major function is to publicize the performance of the subject. Users can visit this column through related links in the original website of the school. The second is teaching resources which is divided into several submenus, such as excellent teaching plans, collection of teaching materials, teaching video, reference resources, intra-station teaching material search, and so on. The third is student self testing system which includes online self testing and assignment assessment. The fourth is interaction between teachers and students, including student message area, teacher message area and technological service supporting area. The fifth is website authority management which divides the management function of the whole website to different people to ensure efficient management and to improve the security of the whole website.

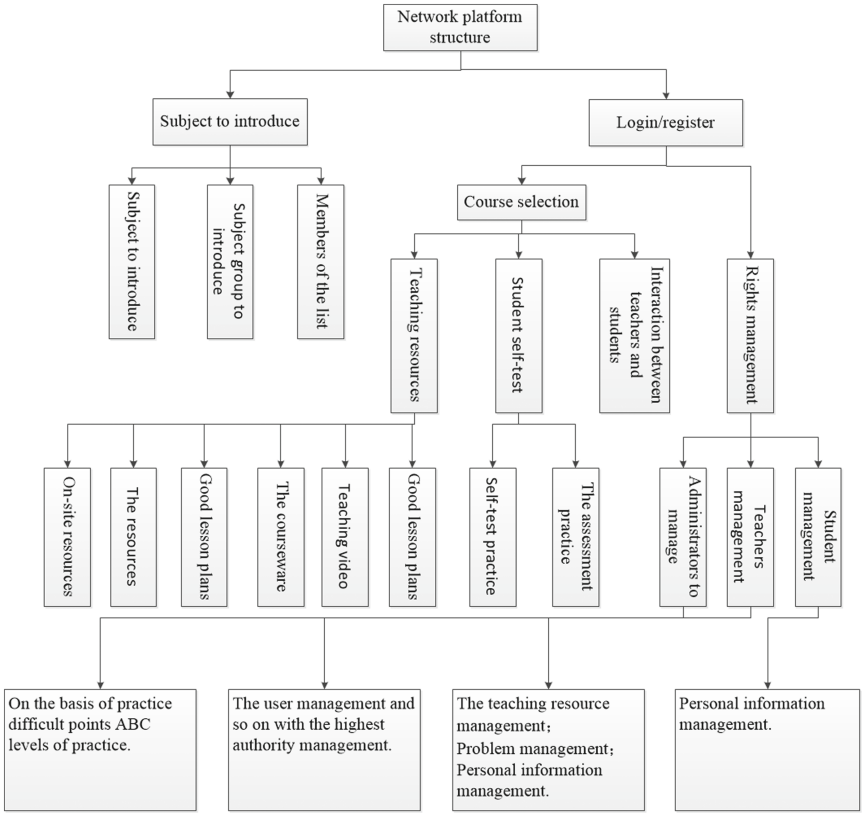

Fig. 2. Interactive platform of the whole structure

3 Results

As for the actual usage of the Internet interactive platform of inquiry curriculum based on the application of artificial intelligence technology, a comparative experiment is conducted to explore the effect of this platform. 100 secondary school students are chosen randomly and divided into experimental group and comparison group with each group being 50 people. Then select an 800-word scientific article which is suitable for secondary school students to read. The experimental group will apply this Internet interactive platform to learn this article, while comparison group will use the traditional teaching model. Thirty minutes later, we have a test for the two groups of students with a focus on the versatility, relativity and innovation of the students' thinking capability. Each test has three grades of A, B, and C. The number of students at every grade is calculated and the percentage results are shown in the following Table 1 and Fig. 3.

Table 1. Students' thinking quality change data tables

	Test scores	Multiplicity			Correlativity			Innovative		
		A	B	C	A	B	C	A	B	C
The experimental group	Before study	1.5	37	61.5	73.5	25.5	1.0	1.7	30.6	67.6
	After study	2.6	44.8	55.6	75.4	24.6	0.0	2.3	34.5	63.2
The control group	Before study	1.8	39.5	58.7	72.8	25.2	2.0	1.5	31.9	66.6
	After study	1.9	40.2	57.9	73.6	24.9	1.5	1.8	32.7	65.5

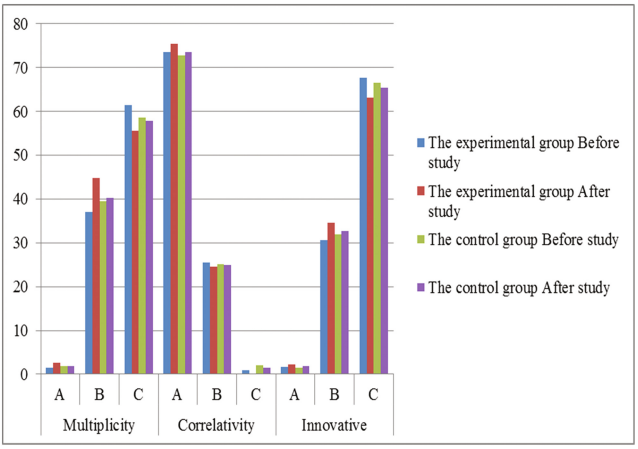

Fig. 3. Students' thinking quality change data tables

The mean and standard deviation of the testing grades of the two groups of students both before and after learning the scientific article are shown in the following Table 2 and Fig. 4.

Table 2. Student achievement the mean, standard deviation

		The average	The standard deviation	Significance test
Before study	The experimental group	81.5	12.74	0.046
	The control group	82.3	10.03	
After study	The experimental group	90.7	5.26	0.185
	The control group	87.4	8.68	

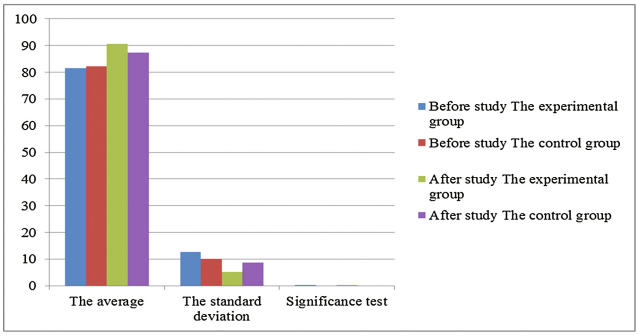

Fig. 4. Student achievement the mean, standard deviation

According to the contrastive analysis of the experimental data, we can conclude from Table 1 that the grades of the two groups of students in the thinking test, after their learning of the scientific article, have increased with students from the experimental group increasing more obviously. From Table 2, we can see more directly that the mean of grades of the experimental group is higher and its standard deviation is smaller, which demonstrates that the grades of experimental group are better than those of comparison group. In the meantime, according to significance test, we can see that the gap between the grades of students from experimental group and comparison group has undergone obvious changes.

4 Conclusions

We advocate meaningful personal inquiry of the students themselves. Therefore teachers should create a favorable inquiry environment for students, namely to provide learning resources, organize learning community and design coordinated activities. The construction of the Internet interactive platform of inquiry curriculum combined with artificial intelligence technology will help teachers to resolve the issue of activity creation, which is also the researchers' objective in the research on this subject. In the research of this paper, we firstly investigate and analyze the research and application status of this subject. Then we research into the theoretical basis demanded by this subject, determine the concept of relevant theories, the design thought of this platform, and the structure of this platform. Finally, through practical experiment, we prove the efficiency and advancement of this thought through data and the method of quantitative comparison. In the meantime, we have found that this platform can not only improve the grades of the students, but also other learning capabilities.

In this paper, we can make the following conclusions. How should inquiry learning get started? Some questions involved should contain or embody the concept, principle and method in areas related to the area of learning. The inquired questions should be free, true and close to the reality. In the meantime, while narrating tasks, we should resort to a more attractive way to introduce the background information so as to present this task more vividly. What's more, the description of the question should be more

detailed, so that students will feel that they are capable of resolving this issue and the resolution of this issue should be meaningful. As for the organizing form of resources, it should be guided by local resources. The navigation resources are a type of supporting resources. Resources which are too abundant cannot effectively improve learning effect. When providing relevant links to such resources, we should try our best to guide students to read the specific part.

Although certain achievements have been made in this paper, this paper still has some deficiencies. In future research, we should pay more attention to consider the changes of the middle school students in their psychological status in the process of the Internet inquiry and help teachers to play a guiding role.

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Research on Intelligent Standardized English Test Systems with Artificial Intelligence

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Abstract. With the advent of the Internet era, computer technology has penetrated into the political, economic, cultural and other fields, which also includes the field of education. In the traditional education mode, large test is often faced with many difficult including high cost of examination, heavy examinations and so on. Therefore, it is an important research on designing a test system combine with Artificial Intelligence. This paper analyzes the related Artificial Intelligent standardized test system, and uses the improved Genetic Algorithm to refine the rules for an Intelligent test paper, and uses Fuzzy and Close matching to intelligent mark, combines with Artificial Intelligence to design optimized standardized English test systems. And does feasibility analysis and related comparisons by the experiment. The results showed that the Intelligent standardized test system not only ensured the fairness of the examination, reduced the costs of the examination, but also assessed the capacity of the candidates more effectively.

Keywords: Artificial intelligence testing · Test system · Genetic Algorithm

1 Introduction

Under the background of the rapid development of information technology, more and more people realize the importance of computer technology in human society. Popularization and development of computer technology, so that the human society digital, intelligent era of digital intelligence and build a new world, it is a different kind of society, giving people more creative and imaginative. Computer platform as a new carrier, had been constantly penetrated into all walks of life.

Among them, the field of education is also facing the challenge of digital and intelligent. The rational and efficient combination of information technology and education system up, based on the examination of the network takes full advantage of the vast network of infinite space, anytime, anywhere the student's exam, reducing test costs, simplify the burdensome examination affairs, is the traditional exam an extension and change [1]. Computer automatic marking, then the results of the database statistics, sorting, summary. Paper produced by the system randomly selected from the exam, thus effectively avoiding cheating on exams and papers leaks and other problems from occurring, protect the examination fairness and security (see Figs. 1 and 2).

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Fig. 1. English test system login interface (Chinese version)

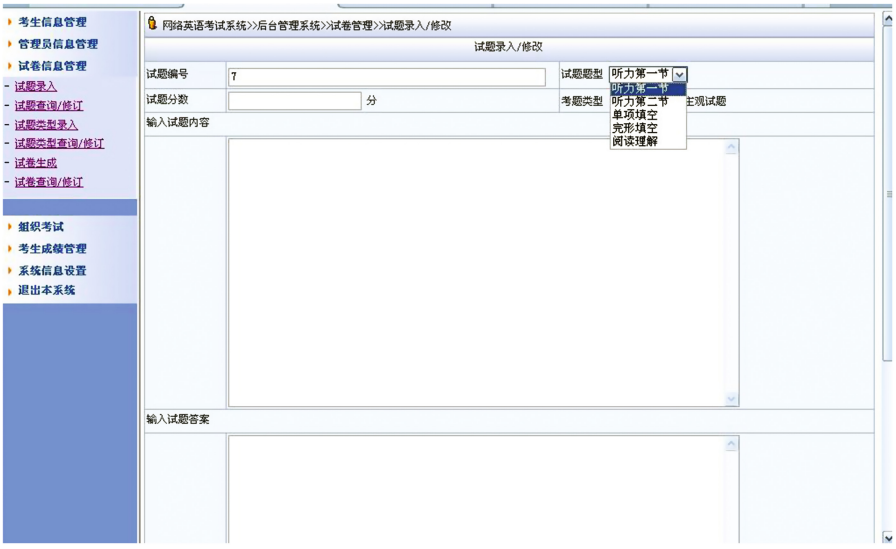

Fig. 2. English online test system (Chinese version)

The second part of this paper analyzes the importance and far-reaching implications of artificial intelligence in the intelligent standardized English test systems. The third part of the optimization design of a standardized English test system includes Intelligent test paper based on fuzzy genetic algorithms and intelligent matching close marking.

The fourth part of the improved Intelligent examination system feasibility analysis. The fifth part summarizes concluded.

2 State of the Art

2.1 Exam Mode

AI education mode of change had a profound impact, particularly in the application of the examination system. In the intelligent network test system based on the system, there are two different test patterns, which are stand-alone mode and network mode [2].

It refers to the stand-alone mode on a single exam. One is to test the system is installed on a single machine, each machine involved in the test must be installed, it has the advantage to ensure the integrity of the system. The other is installed on the administrator's computer system, it has the advantage of flexible organization examination, no separate administrator training [3]. However, this model has a heavy workload, difficult recovery performance, poor security shortcomings.

Network mode refers to the examination through the Internet. Including B/S (Brower/Server) and C/S (Client/Server) mode. C/S mode and test related software and data server installed on the server, the client software is installed on the client, the candidates through the client on the server get questions from the exam, the candidate data stored on the server. C/S mode, the client has a complete application that can provide an error message and online help function, you can switch freely between subprograms; in addition, C/S mode provides a more secure access mode. The B/S model is based on

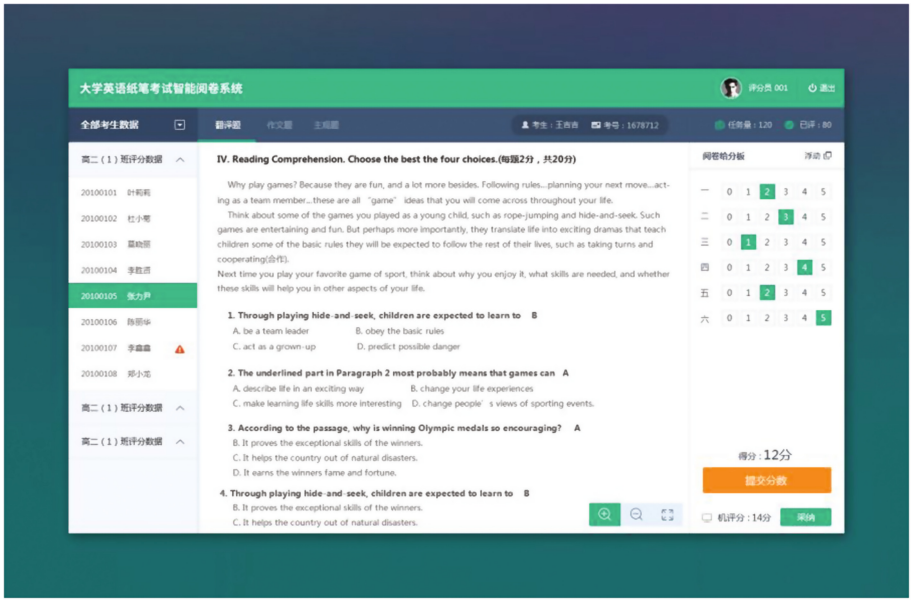

Fig. 3. English Intelligent Test System (Chinese version)

WEB technology, simplifies the client, the C/S mode server decomposed into a data server and one or more application servers, client-server system constitutes three-layer structure. B/S structure model is multipoint, multipoint, using the TCP protocol, relying on the database server data to ensure their safety [4]. Figure 3 is an English Intelligent Test System.

2.2 Related Technologies of Intelligent Test System

There are many test system implementation is too simple, the lack of effective management tools, the examination cannot be unified management and cannot be integrated into the network teaching platform, and a single type of questions, subjective questions enough support, far unable to meet Intelligent replace traditional exams written request [5]. Thus, on these issues, standardized test system provides the following two methods, making intelligent examination system more complete.

One is paper - making strategy. It is to be a fair and equitable measure student mastery of the knowledge, the more difficult for the candidates to generate quite different from each other and papers, and the existing examination system often used randomly selected method, backtracking heuristics, genetic algorithms. Another method is marking Intelligent. Rely on artificial intelligence for automatic marking is the basic function of the mass paperless examination system and the inevitable choice [6]. In a specific development process, the answer for the characteristics of different kinds of questions, design and select the most appropriate scoring policy, to prepare a suitable smart scoring system [7, 8].

3 Methodology

The Paper examination system is the most important part it is important to evaluate the scientific basis for students to acquire knowledge of the situation. It is influenced by various factors of subjects of mutual restraint, Proposition range, score, time, difficulty, discrimination, etc., between, which means that it needs to develop rules for quantitative analysis of various factors, the use of certain algorithms, in order to create a more reasonable test paper. This is also the key to the Intelligent test paper. In addition, in order to reduce the burden of scoring staff to improve the efficiency of scoring, while ensuring the fairness of the examination results [9–11], marking the intelligent use of artificial intelligence, it is an important way.

3.1 Intelligent Test Paper Based on Genetic Algorithms

Genetic Algorithm (GA) is a simulation of natural selection and genetic mechanism of an optimization algorithm, simple and general, universal, suitable for parallel processing, excellent global optimization problem. GA wooden base idea is based on Darwin's theory of evolution and Mendel's genetics [9]. In nature, environmental adaptability biological species through the "survival of the fittest, survival of the fittest" rule

to measure. In the genetic algorithm [12], the fitness function is used to judge the extent of the merits of the individual papers population.

This design of test systems, test database attributes include: question types, question number [13], question text, answer questions, difficulty, discrimination.

The main difficulty of this question refers to all personnel reference purposes losing rate. The formula is:

$$N = 1 - \overline{X} \Big/ M$$

Formula, N on behalf of item difficulty values; $\overline{X}$ on behalf of all subjects' average score on this theme; M represents the value out of the question.

The Difficulty level is divided into five grades, as shown in the following Table 1.

Table 1. Item difficulty level

Difficulty level	1	2	3	4	5
Difficulty factor	0–0.2	0.2–0.4	0.4–0.6	0.6–0.8	0.8–1.0

Discrimination is mainly to distinguish between different levels of students' level of ability, the paper according to the high and low scores to student achievement sort of 30% in front of a high packet, 30% back as a low group, and then calculate the average score PL low packet and the average score PH high packet, if M stands out, which is calculated as follows:

$$Q = PH - PL/M$$

After extensive research and testing, discrimination standards in the following Table 2.

Table 2. Evaluation criteria to distinguish between questions

Discrimination index	Evaluation
More than 0.9	Excellent
0.4–0.89	Good
0.3–0.39	Medium
0.2–0.29	General
Under 0.19	Inferior

3.2 Intelligent Fuzzy Close to Scoring Match

Ratings for the English title, a lot of experts in this area have been studied and discussed. The compiler is generally divided into two phases: phase analysis and synthesis stage. Structural analysis phase analyzes the English exam answers, check compliance with the provisions of the language, including lexical, syntactic, semantic analysis.

Comprehensive analysis phase, according to the target structure required by code procedures. If you find an error source, not only reporting errors, but also for error handling, so the compiler can be continued in the compilation process.

Therefore, we consider an Intelligent scoring system can be used to compile this principle, the standard answers are compiled and candidates answer, then fuzzy nearness matches, thereby performing fractional statistics.

4 Result Analysis and Discussion

4.1 Feasibility Analysis of Genetic Algorithm Improved

This exam tests a total of more than 3,000 test questions, test paper constraint information: noodles out of 100 points: the overall degree of difficulty of 0.5, tolerance disabilities 0.05; item structure of six kinds of questions, 90 min, allowing the error ±5; the scale of the initial population: 100.

Our genetic algorithm and improved genetic algorithm through the same evolution algebra optimal fitness value comparison of the two algorithms produce. Take evolution algebra 10, 20, 50, 100, 200, run the following Table 3.

Table 3. Evolutionary generation and optimal fitness

Evolution algebra	Genetic algorithm	Improved genetic algorithm
10	0.528	0.439
20	0.712	0.683
50	0.872	0.861
100	0.885	0.955
200	0.889	0.987

4.2 Fuzzy Close to Matching Strategy for Standardized Scoring Impact

Because reading comprehension in English exams very representative, in order to fully verify the functionality and accuracy of the scoring model scores, whichever is 6 (A, B) = 0.15, P = 0.7, to read for the exam organized 30 languages in accordance with 10 students in groups of three exams, and in strict accordance with the evaluation criteria by a manual scoring for each of the respondents, respectively, record the score results. The results are as follows (as shown in the Table 4).

These two experiments showed that: the test paper system high efficiency, high speed, high precision marking, can be comprehensively recorded traces of judge candidates to answer, solve the problem of subjective marking Intelligent program theme is reflected in a fairer and objective examination of students' abilities system.

Table 4. Comparison of artificial Intelligent scoring and people scoring

Exam event	People scoring correct number	System scoring correct number	People scoring error number	System scoring error number	Average score	Deviation
1	20	20	44	49	6.9	0.1
2	18	18	57	51	6.7	0.1
3	21	21	41	47	7.2	0.2

5 Conclusions

In this paper, we analyzed the Intelligent standardized test system. In order to design an optimized intelligent standardized English test system combined with artificial intelligence. Based on analyzing the key issues of the test system, through improved Genetic Algorithm to refine the rules for Intelligent test paper, and fuzzy matching close marking intelligent with efficient checking English speech, grammar and other issues, to solve the problem that it is too heavy to score in the large English by people scoring. Compare and optimize intelligent examination system which has reasonable software architecture by analyzing the experimental results, the comprehensive test paper algorithmic rules and powerful, efficient and accurate scoring system and effective feedback scoring ability.

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Research on the Automatic Error Correction Model Combined with Artificial Intelligence for College English Essays

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Abstract. With the explosive development of artificial intelligence technology, the automatic error correction model combined with artificial intelligence has become a research focus in the field of artificial intelligence. Based on this, this paper proposes an automatic error correction model combined with artificial intelligence for college English essays to aim at the tedious, error-prone and time-consuming correction of college essays. Through a survey and analysis of the situation of College Students' English essay error, this paper, taking essays of CET-6 as the research object, firstly assumes that the English essay is in a confusing system. And then an in-depth discussion is conducted on the mathematical, statistical model and technical scheme involved in the intelligent error-correction by using frequency statistics to construct a model according to the characteristics of the confusing system. Finally, correcting suggestions are given through the experiment, which realizes the intelligent error correction of words and grammatical mistakes in college English essays. The experimental results show that the proposed automatic error correction model can not only analyze the spelling errors and grammatical errors, but also correct them automatically.

Keywords: Artificial intelligence for teaching · CET-6 · Error correction model

1 Introduction

English is a most widely used international language with the most people speaking it in the world, more than 10 countries taking English as their mother tongue, the official language of 45 countries being English and one third of the world population (over two billion) speaking English. For example, Japanese take English as their second language in addition to their native language, and many high-profile Japanese regard it as an honor to be able to speak English. Reading and writing of English essay is an important standard to evaluate English abilities. As the automatic scoring technique of English essay advances, spelling errors and grammatical mistakes will be the indispensable indicators of evaluation. Automatic detection and correction for words, spelling and

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grammar errors through intelligent language processing technology will be very helpful to improve the students' English writing level, and also will be beneficial to the improvement of objectivity and accuracy of the automatic scoring. In addition, it saves teachers the time and energy to mark students' writing so that they will be able to focus on the overall structure and the content of the composition. The automatic error correction model combined with artificial intelligence comes into being to meet this demand. This paper focuses on the application of automatic error correction model combined with artificial intelligence in college English essays. After firstly analyzing the common vocabulary easy to be mixed in College English essay writing, some typical confusing areas are selected as the test cases. If the input text contains words in the confusing area, the system's word error handling module will be triggered to perform automatic checks and correction of word errors. Then, an appropriate man-machine interface will be designed to greatly improve the speed and accuracy of processing of interlanguage corpus. The research reported in this paper has investigated all kinds of learning objectives of high school and college preparatory English textbooks using an Iran representative Bloom's taxonomy [1]. And the work plan is conducted on the basis of the National College English proficiency test. The Internet is now a common tool for universities. Many college English courses require the students to use both family production and business computer programs to deal with their own work [2]. English is an international leading social linguistics in our times. Before it became the dominant language in the world, religious languages such as Hebrew, Greek, Latin, Sanskrit and the Qur'an by Arabic are in domination [3]. We have no idea whether the motor and the sensory pathways with the missing neural association are maintained around the amputation or chronic peripheral. The nerve is in good function months or years after the transaction [4]. Stock index prediction is a hot issue in the financial field. Because the stock index changes are nonlinear, and subject to a lot of internal and external factors, this is a great challenge for researchers trying to predict [5].

2 State of the ART

In the 50s of the last century, some research on the English text automatic proofreading has been carried out in foreign countries. In 1960, the research center of IBM Thomas J. Watson produced the TYPO, an English spelling checker with UNIX on the IBM/360 and IBM/370. In 1971, Ralph Gorin of Stanford University realized an English spelling checker Spell on DEC-10 machine. Over the years, with the continuous development of computer technology, the new input technologies continue to emerge, such as OCR recognition and speech recognition. Identification of the spelling error recognition becomes more urgent, and research on this has also achieved constant progress. Some of the popular text processors, such as Word and Word Perfect, are embedded with English spelling check function. We can also see English spelling check system including Deal Proof issued by Expert Ease and Proofread issued by the Newton company on international internet.

Because there are evident separators between words for English and other alphabetic writing, their automatic proofreading is basically focusses on word proofreading and conducted on two levels: non-word error and real-word error. The former means

that the words don't exist in dictionaries; for example, "the" is written as "teh". The latter means that though the words can be found in dictionaries, they don't match with the context; for instance, "from" is mistakenly written as "form". The improper colection here includes many aspects such as semantics and grammar.

Due to the limitation of computer hardware, early English non-word error-checking methods are built on the N-gram model of letters. These methods attempt to locate a word spelling errors through the discovery of rare letter connections (such as khi). With the rapid growth of computer storage capacity and computing power, non-word error-checking methods are basically transferred to referring to the dictionary. The alphabetic string that doesn't exist in the dictionary is considered wrong. Non-word error correction independent of the context is called isolated-word error correction, the task of which is to find possibly correct words for non-word letter string and put the candidate words in order. The major basis for the selection of candidates is the degree of similarity between candidate words and non-word letter strings. The runoff forecasting has been a major part of the systematic control of water resources and this is a challenging task. In this study, we explore the feasibility of the self-organizing radial basis (SORB) function [6]. The constants of Henry's law are alpha and gamma hexachloride benzene. The function of artificial seawater temperature (0.5–45 °C) is used to determine distilled water (DW) using gas stripping method (SW; 30%) [7]. Artificial bee colony algorithm (ABC) is inspired by the foraging behavior of honey bees and bio inspired optimization, which is more effective than a genetic algorithm (GA), particle swarm optimization (PSO), and ant colony optimization (ACO) [8]. The recent experimental results show that exponentially weighted moving average (EWMA) controller can be used in semiconductor technology to maintain the goal of the long-term process of product quality improvement and reduce downtime [9]. To determine the removal of ovarian function, we have studied 26 women in 52 cycles of artificial reproductive technology and the effects of forward laparoscopic tubal ectopic pregnancy [10]. A more general vector autoregressive (VAR) model can be used in tax, spending and consumption. Federal spending is divided into several categories. Automatic stabilizer is deleted to help co-integrate and build error correction models [11]. It is used in automatic alignment and error correction for the human generated transcription by LongSpeech recordings. We can align the audio data at the correct time and convert the audio data into an acoustic model for speech recognition [12]. Modeling provides a correction algorithm for the pre-treatment of volume gain in the whole image or volume gain variation by reducing the number and numerous attempts of systematic error [13]. Patients with bilateral lesions of PPC fails to show the error of their automatic correction action, but they can make a slow and deliberate motor correction. Therefore, Desmurget and Grafton have proposed one of the models of error correction [14]. The error correction algorithm proposed in this paper is realized through the following mixed integer quadratic problem: in the numerical experiments, we restrict the probability of their automatically deletion and combine it with five times cross tuning [15].

3 Methodology

3.1 Introduction of Artificial Intelligence

The definition of artificial intelligence can be divided into two parts, namely "artificial" and "intelligent". "Artificial" is relatively easy to understand with less controversy. Sometimes we have to consider what is within the human's ability to manufacture or whether the intelligence degree of human itself is high enough to be able to create artificial intelligence, etc. But generally speaking, the "artificial system" is the manual system in literal meaning.

Nelson, a professor of Research Center for Artificial Intelligence in the famous Stanford University, gives artificial intelligence, such a definition: "Artificial intelligence is a discipline about knowledge: the science of how to show the knowledge and how to acquire and use the knowledge." And Winston, a professor at the Massachusetts Institute of Technology, said: "Artificial intelligence is the study of how to make computers do the intelligent work that can only be done by human in the past." These statements reflect the basic ideas and basic contents of artificial intelligence. Artificial intelligence is to study the rules for human intelligence activities, construct artificial systems with certain intelligence, and research how to make computers to accomplish works requiring human intelligence. That is to study the basic theory, methods and technology of how to make use of the hardware and software of computers to simulate the human intelligence (see Fig. 1).

Fig. 1. The robot that is based on artificial intelligence inputs English words

The relationship between artificial intelligence and thinking science can be viewed as the relationship between practice and theory. Artificial intelligence, as a branch of its application is at the level of technology application of thinking science. From the viewpoint of thinking, artificial intelligence is not limited to logical thinking; image thinking and inspiration thinking should also be taken into consideration to promote the breakthrough in the development of artificial intelligence. Mathematics is often considered as a multi-disciplinary basic science and has also entered the field of language and thinking. Mathematical tools are also required in the artificial intelligence discipline. Mathematics not only plays its role in standard logic and fuzzy mathematics,

but also matters in the discipline of artificial intelligence, which will contribute to their faster development through mutual promotion. Meanwhile, artificial intelligence has also made important achievements in the field of automatic error correction. This paper is aimed to establish an automatic error correction model for college English essays taking advantage of the application of artificial intelligence in error correction.

3.2 Survey of Errors in College Students' English Essays

In recent years, great progress has been made on surveys of errors in college students' English essays, which are mainly conducted around the planning project themed "some research on Chinese English learners based on the corpuses" of the national philosophy and social science in the "Ninth Five Year Plan". Among them, the research by Gui Shichun is the most comprehensive and detailed. In the error tagging of Chinese learners' English corpus, broad classes and the corresponding subclasses are designed. The broad classes include morphology, verb phrases, noun phrases, pronouns, adjective phrases, adverbs, prepositional phrases, conjunctions, vocabulary, collocation, and sentences. The most common speech errors of Chinese English learners include the three subclasses under morphology of spelling errors, word-building errors and errors in capital and small letters; the five subclasses under vocabulary of substitution (the part of speech is correct, but inappropriately used), word missing, wrong part of speech, redundancy and ambiguity; the four subclasses under syntax of segmentation, punctuation, sentence fragments and structure defects; the four subclasses under verb phrases class of inconformity between subject and predicate, tense, modality and transitive type; the three subclasses under noun phrases class of the number of nouns, uniformity between the noun and preposition or pronouns and articles; the two subclasses under other class of verb-noun collocation and pronominal reference. The research on accurate automatic syntactic analysis and syntactic analysis aimed at essays with syntax errors is still far from satisfactory. The recognition of pronoun errors requires accurate automatic co-reference resolution, which is a major problem in natural language processing. Some of other types of speech errors, especially lexical errors and syntactic structural defects, and other classes of verb-noun collocation can be accurately identified through study of relevant words and phrases, the help of a large-scale corpus statistics of native language and the support of human-computer interaction when necessary. Combined with artificial intelligence, the error correction of College English essays can be better accomplished.

3.3 The Implementation Process of Automatic Error Correction Model

Provided the English essay is a confusing region,

$$M_{wrong} = (x_1, x_2, x_i, \ldots, x_n) \tag{1}$$

In the confusing region are words easy to be confused due to cognitive errors of students in writing. These words are very similar in spelling or pronunciation, which

makes it easy for the students to misuse the words in writing. The confusing region can be divided into two categories according to the parts of speech, which are words with same parts of speech and words with different parts of speech. Jack and other people have researched and summed up some confusion-prone words in writing from a large number of English articles. After analyzing common confusable words involved in college English essay writing, some typical confusing regions are selected as test case of the research. If the input text contains words in the confusion set, the word error processing module of the system will be triggered to implement automatic checking and correcting of the word error (Table 1).

Table 1. The words that is easy to be wrongly written

{accept, except}	{vain, vein}	{desert, dessert}
{peace, piece}	{weak, week }	{principal, principle}
{here, hear}	{raise, rise}	{affect, effect}

When the parts of speech of confusable words in the confusing region are the same, the word context feature contributes more to the ambiguity elimination of college English essays than the lexical collocation feature. And when the parts of speech are different, lexical collocation features will be more effective. In some specific situations, if these two types of features are used in disambiguation for English essay simultaneously, problems of feature coverage and conflicts may occur. Based on this, this paper selects the feature type with greater contribution as the main disambiguation standard according to the different parts of speech in the analysis of errors in college English essay. As for the training corpus, this paper picks up 200 English model essays as raw materials, and tags the part of speech of the words in 90% of the texts through the Viterbi dynamic programming algorithm in Markov models. As the word input training corpus, the annotation selected is the Brown tag set. The remaining 10% of the corpus is taken as test data (Table 2).

Table 2. Brown tag set

CS	Subordinating conjunction	if, although
CC	Coordinating conjunction	and, or
CD	Cardinal numeral	one, two
DO	/	/

The structure of the training text after speech tagging processing is shown as in the table. A slash "/" is used as a separator between words and tabs, and "word/part of speech" is regarded as a basic unit of the training text. Until now, the language materials for training are ready and will be used as data input and basis of the follow-up model training (Table 3).

After the feature is selected, we will assign weight according to the degree of its contribution. If the correlation between the feature and the head-word is relatively high, it indicates that when the feature appears, it is more likely for the head-word to appear.

Table 3. Training text markup structure

Word	IF
Separator	/
Part of speech	CS

Here the correlation is measured by mutual information. In addition, if the current feature has relatively high correlation with other confusable words in the confusing region where the head-word exists, it demonstrates that its validity for separation of confusable words is rather low. Therefore, the weight of the features is determined by both the correlation and discriminant validity. The specific definition is shown in the following equation:

$$G(x) = RELATIVITY(f, w) \times DISTINCTION(f, w), \tag{2}$$

$$W(x) = RELATIVITY(f, w) = \log\left(\frac{P(f, w)}{P(f) \times P(w)}\right), \tag{3}$$

$$DISTINCTION(f, w) = \frac{COUNT(f, w)}{\sum_{i=1}^{n} COUNT(f, w)}, \tag{4}$$

where f stands for features, $COUNT$ stands for the frequency of representation, and $P(*)$ stands for the probability of its occurrence; $RELATIVITY(f, w)$ is used to measure the correlation between f and w, and $DISTINCTION(f, w)$ is used to measure the discriminant validity of f respect to w. They determine the weight of features respect to the head-words. Through the training, we can get the error model of college English essay as the table shows (Table 4).

Table 4. College English passage error model

The confusing words	Principal	Principle
Separator	/	/
Feature	RW + 2_CD	RT − 2 CS
Separator	/	/
Weights	4.2563	–2.5613

In the table, the weight of word context feature "RW+2_CD" toward the head-word "principal" reaches 4.2563, and it indicates that "CD" is located at the forth position on the right of the head-word. The weight of collocation feature "RT−2_CS" toward the head-word "principle" is −2.5613, and it identifies that "CS" is located at the second position on the left of the head-word.

This paper conducts disambiguation for wrong semantics by optimal combination prediction algorithm based on recommended candidate list.

Provision 1: d_1 is the word required to conduct error check of college students' English essay in the test case. And according to the definition of confusing region before, the words easy to be confused are

$$d_2, d_3, d_4, \ldots, d_i, \ldots, d_n, \tag{5}$$

Provision 2: d_1 is the head-word of the extraction window, and the context feature set extracted from the current sentences is

$$K_{wrong} = (y_1, y_2, y_i, \ldots, y_n), \tag{6}$$

We choose word context feature in the same situation. And the formula can be established as follows:

$$S(w) = \sum_{f \in K_{wrong}} G(x), \tag{7}$$

You can find out the word with the maximum error in college English essays through $S(w)$.

4 Result Analysis and Discussion

The error checking and correction of non-word errors in college English essays is realized on the basis of dictionary look-up method. The construction of the dictionary itself contains the attribute of words and word frequency. That is to say, the capacity of words in the dictionary and its corresponding frequency, to a large extent, determines the performance of the non-word error handling. Words stored in the word attribute are mainly used to check whether words in the text make non-word errors, so vocabulary should be taken into consideration here. If the vocabulary is too small, the system will mistaken the right words as wrong words because of its lack of the correct one. If the vocabulary is too large with many "uncommon words" or "unfamiliar words" included in it, this will also affect the effect of spelling check. If the dictionary covers the words of writing and reading of CET-6, the system can detect the word error and give amendment advice. Therefore, based on the discussion above, the words of this dictionary cover those of writing and reading of CET-6, totaling about 6,000. It can better satisfy the spelling check and correction requirements of college English essay writing. As for attributes of word frequency, the data comes from the frequency statistics of the training text. When the error occurs in a word, there are often multiple candidate words, and the one with the highest "degree on use" among the candidate words is more likely to be the word the students actually want to write. The selection of training text involves two questions: one is the selection of text type, and the other is the size of the text. We have accomplished such an experiment to select three kinds of training text with different degree of difficulty (model essay of middle school students, model essay of CET-6 and articles in *The Economist*). For each type of text, we calculate the accuracy rate of correction for non-word errors with general morphology under a

different number of texts, and then compare them to find out which one can obtain the optimal value. Obviously, the corresponding text type and text number to the accuracy rate have answered the two questions on training text selection. The specific experimental data refer to the Fig. 2.

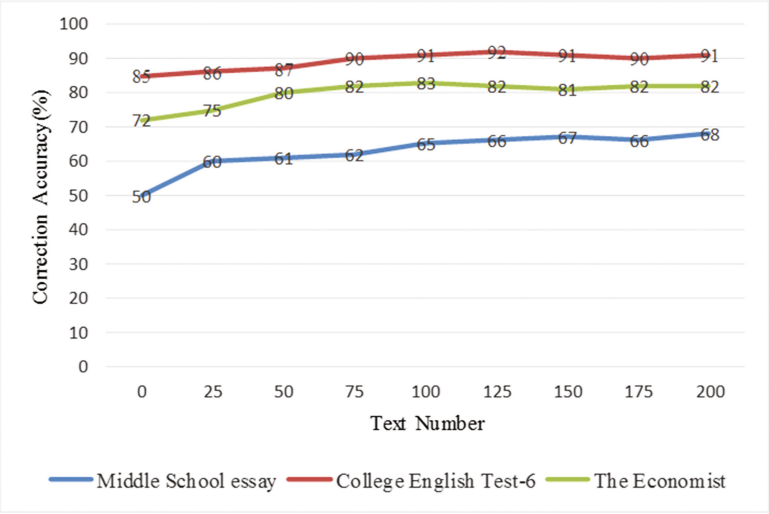

Fig. 2. Sample survey

It can be found from the figure that the correction effect is better than that of the other two text types when model essays of CET-6 are selected as training texts, and the correction accuracy reaches the highest value of 92% when the text number is 125. Because it conforms to the wording scope and habits of CET-6 writing, the word frequency attributes can better service the spelling check of CET-6 essay writing. Therefore, this system selects 200 model essays of CET-6 as the training texts, which is used in word frequency statistics of the ordinary morphological dictionary. The effect of model essays of middle school students in the test is the most undesirable mainly because of the over simplicity and singularity of their wording. The articles of The Economist tend to use words that conform to the native speakers' writing habits, which is different from the writing of CET-6. Taking into account the analysis above and the main research object of this thesis– college English essay writing, it is feasible to use this simulation system to help the automatic error correction of college English essays.

5 Conclusion

English essay writing is a very effective way of communicating. If there are grammar and spelling errors of words, the efficiency of reading will be greatly reduced. Therefore, how to conduct an automatic inspection and correction for grammatical errors and spelling errors in the essays through artificial intelligence technology

becomes the focus of this study. This paper selects three kinds of training text with different degree of difficulty (model essay of middle school students, model essay of CET-6 and articles in *The Economist*). For each type of text, we calculate the accuracy rate of correction for non-word errors with general morphology under a different number of texts, and then compare them to find out which one can obtain the optimal value. In this paper, the author focuses on the analysis of non-word errors, word errors and grammatical errors in students' writing, discusses related problems and establishes an automatic error correction model combined with artificial intelligence for college English essays. The preliminary experiment demonstrates relatively good correction effect, which can satisfy the needs of college English error correction. However, due to the complexity of natural language, especially the complexity of Chinese college students' English writing, the interlanguage with numerous error types and quantities, the current automatic error correction of college English essays can only be performed from some superficial linguistic analysis and certain errors still exist. Therefore, the model needs to be continuously improved in its application.

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A New Model for Analyzing the Win Probability and Strength of the Two Sides of the Table Tennis Match

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Abstract. Table tennis contest is an important event in the sports competition. Strength against both analyses is often table tennis game analysis in comparison to the index. The purpose is to make the country engaged in table tennis coaches, athletes and the scientific research personnel, in the face of strong antagonism, competitive major competitions, open mentality, improve the tactical thinking quality, reduce the game decision-making errors, increases the chances of winning. Further enrichment of table tennis tactical analysis theory, for the Chinese table tennis team for excellent results in the Olympic Games to provide theoretical support. In this paper, the design of a novel calculation method and the model was put up, through the calculation of the model can obtained effectively against the pros and cons of both sides and differences and both sides win probability, more effective for analysis of the war, is conducive to the formation of a fierce confrontation, highlights of the game, is conducive to the purpose of its market development and interests of the sponsors.

Keywords: Win probability model · Intelligence analysis · Table tennis

1 Introduction

The Internet age we are faced with the amount of data that will be more and more bigger, in the face of a huge database, how to fully use the data effectively, improve the quality of data. Scientists in combination with a multidisciplinary algorithm to create data mining on the basis of the subject [1]. Is through the computer with the aid of statistical data mining related principles derived from a large amount of data we are interested in, or derived from observation of huge data and analysis of the relationship of cannot easily detect or assertion, useful and understandable conclusions finally. Data mining in the late 1980s, after 20 years of development has been widely used in the field of data analysis, data mining of data mining is becoming more and more important in the game data analysis [2]. As a research from the number of random phenomena statistical regularity of a mathematical subject, the theory of probability is in science and technology, management, and has wide applications in such fields as economy, increasingly deep into our life and work. Similarly, in order to meet the "higher, faster, stronger "sports spirit, or to increase the competition of suspense, or increase the competition of the match is exciting, or maintain fair competition, probability in the

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formulation of the rules of sports competition also has a broad application and embodiment. Probability analysis, also known as risk analysis, through the research of various uncertainty factors have different variations of probability distribution and its influence on project economic benefit indexes, and feasibility of project risk and using an uncertainty analysis method of judgment [3]. Probability analysis is often used in several important for large and medium-sized projects evaluation and decision making. The project evaluation exercises include the expected value method, utility function method and model analysis as given in [4]. (1). Expectancy Method: expected value method is the most widely used in project evaluation, it is through the calculation of expectations and the net present value of project net present value is greater than or equal to zero, the cumulative probability to compare advantages and disadvantages, determine the feasibility and the degree of risk. (2). Utility Function Method: It includes the So-called utility, efficiency, value or contribution to the overall goal is the size of a measure. In the case of risk decision, usable utility to quantify decision makers' attitude to risk. Through this measure, some can be hard to quantify, there are qualitative differences (events) to give quantitative, will consider factors are converted into the utility value of comprehensive utility value to different schemes are obtained, and then make decisions. The utility function reflects a policy maker's attitude to risk. The utility function varies in many environments. (3) Model Analysis: Using the computer simulation technology, the simulation analysis is to simulate the uncertainty of the project, by extracting project uncertainty distributed random number, calculate project economic effect evaluation index, and it is inferred that it is required to provide a project on the impact of uncertainty on project economic indicators comprehensive situation [5]. Probability analysis is based on the uncertainty factors in a certain range of random change, analysis and determine the probability distribution of the shift, and the expected value and the standard deviation are calculated for the project risk decision provides the basis of an analysis method. In sports, it is full of uncertainty, probability theory and play a unique role in the objective or subjective, and the probability of hidden behind this knowledge for us to better understand the charm of sports plays an important role, and also can play a better probability of role, for the development of sports and make greater contribution to human progress [6]. As an applied strong discipline, probability theory has deep into our life and work, and expanding its application scope and depth.

Two athletes in the game have the strength of the stability of the situation and the single ball score probability has been always in a fixed value fluctuation [7]. Assuming that the probability of winning a, B two players of the game in the process of each ball is fixed, then both sides of a single Bureau winning probability can be calculated. Both sides eventually winning probability can also and according to the rules of the game are calculated [8]. The effect can be analyzed from two aspects, one is conducive to a modest increase in the game of chance; the second is conducive to the formation of the fierce confrontation, making changes in the competition system can achieve the desired effect of the practice. Contingency focuses on the outcome of the game, while the intensity of the analysis focuses on the course of the game [9].

The chance of the game is to refer to the situation of the weak against the strong, through the probability function for drawing, you can draw the changes in the strength of both sides and the chance to increase the competition but not excessively. The fierce

competition of can be defined by a single game of expectations [10]. The closer the score of the game, the greater the intensity of the game, the more able to stimulate the enthusiasm of the audience. Also increased the objective of the game, at the same time, the similarity score will inspire the potential of game players, increase the probability of winning.

2 Problem Description and Analysis

Given a user's query string, relative to the string is a set containing all of the relevant documents. We think this collection as an ideal result document collection, after the better outcome set is given, one can get the outcome normally. So that we can put the query processing set properties as the result of the ideal document processing. The problem is that we cannot know exactly these attributes, but we know there are indexing terms to represent these attributes. Due to these properties are not visible during the query, this needs to estimate these attributes in the initial stage. The initial phase of the estimates for the first time allows us to retrieve the document collection to return to the ideal result sets, and generate an initial probability description [11].

Probability analysis, by calculating the project target (such as net present value) of the expected value and the target value is greater than or equal to the zero cumulative probability to determine the size of project risk, provide a basis for decision-making for the investors as shown in Fig. 1.

A, B two table tennis team for a five games of table tennis, playing two factions of the 3 players, and each has three players in order of appearance (denoted as α_1, α_2, α_3 and β_1, β_2, β_3). According to the past record of performance can be predicted that if a team in order of α_i appearance and B team in order β_j to play, play five games a team defeating a_{ij} the bureau is full.

Table tennis match against both sides who win can be seen as a probability problem. So we can use the ideas and methods to solve the problem of probability to analyze this problem. According to the meaning of the example, each team 3 players to play, and each has 3 kind of out of order. (Record as α_1, α_2, α_3 and β_1, β_2, β_3). Based on past experience and matrix bureau gives play 5 games a team A win. We can find out the probability of winning each game in some kind of appearance in the two sides through this matrix, and the corresponding matrix is obtained. Because it is a system of three victories in five games, winning situation, including: winning the first three innings, end of the whole; finished fourth after the end, namely the first three innings only won two innings. After finishing the fifth inning, namely the first four games only won two innings. We can then seek out the probability of winning the A team in the whole game.

We can compare against the two sides in a variety of appearances in order to determine the average value of the game to determine which side of the strength of the strong. Events in another event B have occurred under the condition of probability. We can find out each team in the selection of a certain appearance order, to win the whole game of probability, which can actually be regarded as the problem of conditional

Fig. 1. Table tennis match

probability. The probability of a large average is the secure solution for the desired. For example a team choose A1 exit plan won the probability of the whole game, calculated in the B team to all appearance scheme, a team winning probability of the average value, if the average than A2, A3 great, for a team, A1 scheme is secure scheme. Here, but also to seek out the B team of a variety of matrices. Similar to the problem (two), a more secure solution is to be the program. Due to the competitions exist has not hit the full five games at the end of, because the game is to take the best of five sets, if in five games before the results of the competition are out, there is no need for the following a few games. (shown in Fig. 2)

COUNTRY	MAINLAND CHINESE BORN
China	6 of 6
Singapore	5 of 5
Australia	3 of 6
United States	3 of 6
Canada	2 of 2
Turkey	2 of 2
Netherlands	2 of 3
Spain	2 of 3
Portugal	2 of 5

Fig. 2. Table tennis match score and the outcome

3 Model Building

Generally speaking, the method of mathematical model is established in general can be divided into two kinds, one kind is mechanism analysis method, one kind is testing analysis method. The mechanism analysis is based on the understanding of the real

object properties, analyzes its cause and effect, find out reflect the law of the internal mechanism, establishing the models often have clear physical or practical significance.

The game is to win the final victory in the three games five wins game by the three games five wins system which is the real victory. Here we calculate the probability of winning the final victory in the three games of the five games.

Let $p_{ij} = P_{1ij}$,

(1) If the first of three wins, the probability of this situation is p_{ij}^3.
(2) If the two of three wins, the probability of such a situation is Formula (1).

$$C_3^2 p_{ij}^2 (1 - p_{ij}) p_{ij} = 3p_{ij}^3 (1 - p_{ij}) \tag{1}$$

(3) If the two games wins in the four games and the last one. The probability of such a situation is Formula (2).

$$C_4^2 p_{ij}^2 (1 - p_{ij})^2 p_{ij} = 6p_{ij}^3 (1 - p_{ij})^2 \tag{2}$$

The probability of winning the final victory in the three games of the five games is Formula (3).

$$\begin{aligned} q_{ij} &= p_{ij}^3 + 3p_{ij}^3 (1 - p_{ij}) + 6p_{ij}^3 (1 - p_{ij})^2 = p_{ij}^3 [1 + 3(1 - p_{ij}) + 6(1 - 2p_{ij} + p_{ij}^2)] \\ &= p_{ij}^3 (10 - 15p_{ij} + 6p_{ij}^2) \end{aligned} \tag{3}$$

The average winning probability for the A team is Formula (4)

$$\mathrm{p1} = \left(\sum_{\mathrm{i}=1}^{3} \sum_{j=1}^{3} r_{ij} \right) / 9 \tag{4}$$

The average winning probability for the B team is Formula (5)

$$\mathrm{p2} = \left(\sum_{\mathrm{i}=1}^{3} \sum_{j=1}^{3} \mathrm{q}_{ij} \right) / 9 \tag{5}$$

4 Solving Model

The model is solved as follows,

(1) $\mathrm{p1} = \left(\sum_{\mathrm{i}=1}^{3} \sum_{j=1}^{3} r_{ij} \right) / 9 = 0.52$, $\mathrm{p2} = \left(\sum_{\mathrm{i}=1}^{3} \sum_{j=1}^{3} \mathrm{q}_{ij} \right) / 9 = 0.48$, $\mathrm{p1} > \mathrm{p2}$, A team strength is stronger.

(2)

$$p_{\alpha 1} = \left(\sum_{j=1}^{3} r_{1j}\right)/3 = 0.44,\ p_{\alpha 2} = \left(\sum_{j=1}^{3} r_{2j}\right)/3 = 0.54,\ p_{\alpha 3} = \left(\sum_{j=1}^{3} r_{3j}\right)/3 = 0.58.$$

A team's most secure program is the order of α_3 appearance.

(3)

$$p_{\beta 1} = \left(\sum_{j=1}^{3} q_{1j}\right)/3 = 0.56,\ p_{\beta 2} = \left(\sum_{j=1}^{3} q_{2j}\right)/3 = 0.53,\ p_{\beta 3} = \left(\sum_{j=1}^{3} q_{3j}\right)/3 = 0.35.$$

B team's most secure program is the order of β_1 appearance.

(4) When the A team in order to α_3 the B team in order to β_1 fining the corresponding R2, or Q2 matrix, that will eventually win the A team. Under the steady scheme, the A team won the probability of 1, so will choose to play in the order of the competition.

5 Conclusion

Competition for the five war three wins, but the element of the matrix R is in full play in the case of the five sets of the data processing and forecasting methods have shortcomings. Although it is playing the full five games to get in, but it can be speculated that the strength of the two teams, in order to guide the appearance scheme that just played the full five games to get in, does not meet the actual specifications of competitors, so the above is for reference only, but cannot completely rely on. For other events, such as tennis, volleyball, as well as chess, we can also take the above similar programs, the establishment of the corresponding model, so as to find the optimal solution.

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Intelligent Remote Control in Real-Time

Water Quality Turbidity Detection Based on Image Recognition System Design and Implementation

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Abstract. The people of the importance of environmental protection is becoming more and more high, in which the water as the source of life literally become the top priority, to monitor the turbidity of water is very important, so water quality turbidity detection based on image recognition system design has become a hot research topic. In the study, first has carried on the investigation to the current research status; And then need the technology and theory in the process of system design are analyzed; Then theory with practical design improved the water quality turbidity detection based on image recognition system; Finally, the system has carried on the actual experiments, and through the contrast analysis of the experimental results verify the feasibility and advantage of the system. The research results prove that the turbidity of the water quality detection based on image recognition system more scientific and reasonable than the traditional system.

Keywords: Image recognition · Turbidity · Neural network

1 Introduction

With the development of social economy and people living standard rise, people began to pay more attention to the environment, protect the nature. And water, as the source of life, nature won people's great attention. Among all the governance, water quality testing, in necessary measures against water pollution again, is particularly important. For turbidity (one of the main indicators of water quality tests) detection is more important.

For the purpose of this article puts forward the topic, there have been many studies scholars are studied, and got good grades. Turbidity represents the degree of clear water its synthetically reflects the all kinds of impurities in water, including sludge, microorganisms, all kinds of inorganic salt and so on [1]. Image recognition technology mainly depends on the emergence of digital image, through a variety of means of digital image processing, extracted from the collected digital image correlation of image information (such as image gray level and gradient, etc.), and the information with our actual need identification information (such as speeding the pictures of the license plate license plate number, indicating value of the current in the images of the

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instrument, etc.), so as to convert image information to the actual information of what one needs [2]. An Artificial neural network is a human want to use machine to replace the product of the human brain to complete various tasks, its core idea is to rely on the existing computer technology, to modeling of the human brain, by establishing relatively complex parallel discriminant logic to obtain similar thinking discriminant ability of the brain [3]. The emergence of image recognition technology makes use of machines to replace human beings need to experience before it becomes possible to distinguish, so, should belong to the intelligent technology of image recognition technology [4]. In pattern recognition, neural network plays a crucial role. Between different pattern in the process of pattern recognition, often have some regularity features, but in most cases, these abstract rules are not linear, so need through the neural network to establish the connection between the model characteristics and categories [5].

The second part of this article to involve the related technology and theory are analyzed; The third part has established the turbidity of the water quality detection based on image recognition system; The fourth part on the system tested and analyzed with the result of the experiment; The fifth part is the summary of the full text, and pointed out the future research direction.

2 Existing Condition

2.1 Water Quality Turbidity Detection

Turbidity as a symbol of water turbidity degree, its specific definitions related to degree of pervious to light of the sample under test, turbidity is usually defined as when the light through the sample, the sample of the light will not straight through it will be absorbed by scattering and the optical characteristics of samples is the turbidity. Turbidity is refers to the suspended solids in water to light through the obstacles that occurs. The suspended solids in the water is generally soil, sand, fine organic and inorganic matter, plankton, microbes and colloid material, etc. The turbidity of water is not only related to the water content of suspended matter, and their size, shape and refraction coefficient and so on.

Turbidity measurement principle: first of all need to rely on light source, the current commonly used pure monochromatic light source including incandescent light, laser, light source, etc.; Second, also need to design the light path, can by comparing the scattered light with the original light source to measure turbidity, also can shine by comparing with the original of the light source to measure turbidity; Finally, the CCD (charge-coupled device) devices are needed to test the strength of the light path parts, and through the theoretical formula to calculate the turbidity [6].

There are two ways of measuring the water turbidity. The first is a spectrophotometric method, suitable for drinking water, natural water and high turbidity water, low turbidity of 3 degrees. The second is visual turbid method, is suitable for potable water and source water of low turbidity water, low turbidity to one degree. The water should be no debris and heavy particles, such as the vessel is not clean, or there are dissolved in water bubbles and non-ferrous material interference measurement.

2.2 Image Recognition

Image recognition, refers to the use of computer image processing, analysis and understanding, to identify the different patterns of target and the like. General industrial use, adopt industrial camera images, then reuse software according to the differences of image gray-scale further recognition processing, image recognition software foreign delegates have apparent resistance etc., domestic representative figure intelligence, etc. Image recognition is an important field of artificial intelligence, the other in geography, the remote sensing image classification technology. As shown in Fig. 1, for the application of image recognition in the field of face recognition.

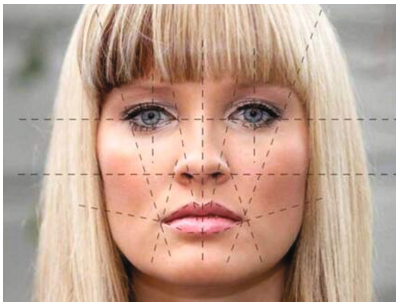

Fig. 1. Human face image recognition

Image recognition may is based on the main feature of the image. Each image has its own characteristics, such as the letter A has A sharp, P is A circle, and Y center has an acute Angle, etc. Eye movement at the time of the image recognition, research shows that the line of sight is always focus on the main characteristics of the image, which is focused on the image contour curvature maximum or contour direction suddenly changed places, where the largest amount of information. And eyes scan line is always, in turn, from one feature to another feature. Thus, in the process of image recognition, perception mechanism must eliminate the redundant information of input out key information. At the same time, there must be a responsible for the integration of information in the brain's mechanism it can put in stages to obtain the information into a complete perceptual image. In the human image recognition system, the recognition of complex images tend to be from the different levels of information processing can be achieved. For familiar graphics, due to grasp its main features will treat it as a unit to identify, and no longer pay attention to the details of it. This whole unit composed of isolated unit material called chunking, each block is perceived at the same time. In text material recognition, people not only can a strokes of Chinese characters and Chinese character component unit composed of a group of blocks, and a word or phrase can often appear together group block unit to identify. In the computer visual recognition system, image content usually use image characteristics is described. Image retrieval based on computer vision, in fact, a similar text search engine can be divided into three steps: feature extraction, indexed build and query.

The development of image recognition has experienced three stages: word recognition, digital image processing and recognition, object recognition. Character recognition research started in 1950, is generally recognize letters, Numbers, and symbols, from printed character recognition to the handwritten character recognition, the application is very extensive. The study of digital image processing and recognition began in 1965. Digital image storage, compared with analog image transmission convenient compressible, not easy distortion in the process of transmission, processing is convenient wait for a huge advantage, these are for the development of image recognition technology provides powerful motivation. Object recognition is mainly refers to the object of three-dimensional world and environmental perception and cognition, belong to the category of advanced computer vision. It is based on digital image processing and recognition is the combination of artificial intelligence, the research direction of systematics and other disciplines, the research achievements are widely used in various industrial and detecting robot. Modern image recognition technology is a lack of adaptive performance is poor once the target image is strong noise pollution or target image is incomplete tend to have no ideal result. The mathematical characteristics of image recognition problem belong to the pattern space to category space mapping problem. At present, in the development of image recognition, there are three main kinds of recognition methods: statistical pattern recognition, structural pattern recognition, fuzzy pattern recognition. Image segmentation is a key technique in image processing, since the 1970s, its research has a history of decades, has always attached great importance to by the people, with the aid of various theoretical thousands of segmentation algorithm is proposed, and the research is still inactive. There are many ways to existing image segmentation methods, a threshold segmentation method, edge detection method, region extraction method, the segmentation method of combining the theory of specific tools, etc. From the type of image points are: the gray image segmentation, color image segmentation and texture image segmentation, etc. As early as 1965, someone put forward the edge detection operator edge detection and have a lot of classic algorithms. But in recent 20 years, as the image segmentation based on histogram and wavelet transform methods of computing technology, the rapid development of VLSI technology, the image processing research has made great progress. Image segmentation method combined with certain theories, methods and tools, such as image segmentation based on mathematical morphology, segmentation based on wavelet transforms and segmentation based on genetic algorithm, etc. As shown in Fig. 2.

2.3 Basic Knowledge of Neural Network

Neuron model is the basic structure of neural networks, for all the input information need after neurons of layers of discriminant to eventually translate into output information, therefore, neurons in neural network play a crucial role.

Discriminant function, also known as the activation transfer function, mainly used for the result of the weighted sum of the discriminant, resulting in corresponding neurons thinking results. The main forms are: hard threshold function, linear discriminant function, s-shaped discriminant function.

Fig. 2. Relevant personnel are studying the monitoring of water quality turbidity (Source from different files of the Chinese Academy of Sciences)

3 Methodology

3.1 Water Quality Turbidity Detection System Hardware Platform Design

System to select Samsung S3C6410 with Linux operating system as the main platform, the core of the platform peripherals mainly includes fluid under the camera and turbidity meter (validation) for training and testing [7]. The system has strong processing capacity, is a good way to deal with water quality turbidity detection system with large computational cost, including the reference light source, power supply, the turbidity meter, SRAM and reset circuit, clock, serial ports, and the proportion of the cameras.

3.2 Water Quality Turbidity Detection System Software Design

The system contains two work modes: training mode and detection mode.

Training pattern of software design: internal system run at the same time can be divided into three parts, respectively, for the extraction of image feature parameters module, sample generation module and network training module.

Image characteristic parameter extraction module is divided into two processes, and process the image collected and at the same time record the image represented by the turbidity of information, and pass this information to process two, and then continue to repeat until the end of the sampling module notice [8]; Process two complete characteristic parameters from image processing to extract all the work, and the characteristic parameters and the turbidity value passed to the sample generation module.

Sample generation module receives the image characteristic parameters and the turbidity value, and add it to the sample in the library, and check the number of samples, if the number is meeting the training requirements, notifies the image characteristic parameter extraction module end data collection work, and notify the network training module of the neural network training work.

Network training module on the sample library randomly assigned in the first place, make part of the sample to the training sample and the other part of the sample to test samples, and then the neural network training and test. If qualified, the end of the process; if it fails to redistribute samples for training and test again. If still cannot get effective results, within the prescribed number, open image characteristic parameter extraction module, extend the sample library [9].

Detection pattern software design: when the system detection mode, the system is relatively simple, can be understood as a module. This module includes two processes, still process and the process of image feature parameter extraction module one function, but no longer acquisition turbidity value at the same time; Process completed in turn, generate images, processing image gray gradient co-occurrence matrix (or wavelet transforms), to extract the feature parameters, and through the network to measure turbidity value. And these two processes for parent-child relationships, namely can run multiple processes 2, respectively, at the same time corresponding collection and image processing [10].

4 Analysis and Discussion

In order to prove the feasibility of the system and the advanced nature, the system has carried on the actual experiment. Set the training sample size of 1000, training essence was 0.5%, the maximum number of repetitions of 5, the largest sample size of 5000, at the end of the training, in the test mode, the detection of 100 groups of data, the final results as shown in Tables 1 and 2.

Table 1. The turbidity of a water quality detection system based on the gradient of testing data and the actual turbidity data tables

Data set number	1	2	3	4	5
Detection of turbidity	1782	2698	3651	4673	5087
The measured turbidity	1806	2680	3681	4699	5106

Table 2. Based on wavelet transform water quality testing data of the turbidity detection system and the actual turbidity data tables

Data set number	1	2	3	4	5
Detection of turbidity	1364	2896	3397	4026	5487
The measured turbidity	1336	2987	3324	4000	5324

By contrast can see scheme based on gradient its measuring error smaller, this is because when the parameter extraction, gradient scheme more statistically significant characteristic parameters, and can best represent the image represents the turbidity of information, but the gradient computation scheme need is far greater than the wavelet transform, and system operation burden also more accordingly. In practice, the power consumption of the system application into consideration, combined with the gradient extraction method and the test results of wavelet extraction methods, this system can contain two kinds of working conditions. When using an external power supply, using the gradient method to extract information, make the system has high performance, namely in the state of high performance, and the most energy in the use of built-in battery, in order to reduce power consumption, using wavelet method to extract the information, the system is able to operate at a lower frequency, the system is an energy saving mode. Through comparison and analysis of experimental results proved that the system is feasible and advanced.

5 Conclusions

Water is the most important condition of life, so it is crucial for water quality testing. In the current exercise, the turbidity of the water quality is studied using the image recognition system, based on the existing research results of the investigation as well as the basic technology and theory, research, established a new system, and the system has carried on the experimental, through statistical analysis of the experimental results proved the feasibility and the advancement of new system, and confirms the research side is successful and meaningful.

Through the study of this paper, one can get some conclusions as follows. Using the neural network training to remove the influence of image acquisition environment, to detect the turbidity value, compared with the traditional turbidity detection scheme, the scheme of testing environment requirements are lower, the cost is more cheaper. Extraction scheme based on gradient to implement the system of higher accuracy, the system of the computing burden is bigger. Therefore, based on the actual application, when the system power supply adequate, using gradient extraction methods, make the system run in highest performance state; And when using battery power, using wavelet transform to extract methods, make the system run in energy saving.

This paper has made some achievements, but still exist some problems, for the actual testing environment, collected the training of this distribution is not uniform, coverage is not completed, resulting in the actual test results than algorithm is accurate, so the need to further improve the neural network and more accord with the actual sample selection scheme is put forward.

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Application and Enhancement of Embedded Computer Operating System Interface

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Abstract. Interfacing in embedded system is gaining momentum now, as it leads to the effective utilization of the embedded system for different applications. While creating interfaces, the human element is important and it is used as the major focus of the design and development activities. In the development process, the system developers can understand the principles behind the human-machine interaction and the constraints and guiding features. In this work, software design model and hardware layer models are used as inputs in creating a better design for the interfaces. To realize the isolation mechanism, the hardware abstraction layer converted the BSP function. This paper is aimed to research the practical application of embedded computer and operating system interface and compatibility according to the embedded computer hardware abstraction layer of the special structure.

Keywords: Embedded systems · Operating system · Software structure

1 Introduction

Embedded computer systems and equipment have a long life cycle. During their long service process, if they appear fault when the embedded computers need to be changed, often encountering the required components production or short situation, they must be used with other similar devices as an alternative. However, device replacement will pay a significant price verification and confirmation. Therefore, it is an urgent need to solve the problem that how to take a test of the operation of the software without modification on the new hardware [1, 2].

In the normal digital design process, the designers use the Computer Aided Design tools in a more efficient way; however they may not work with embedded design, as it more specific. A high speed of the CPU is required in the desktop computing. But in the embedded systems, the external interfaces such as sensors and actuators and the sequence algorithm control is required. The interface controls can be effectively managed by the CPU [3]. Normally, the people who are interested in the effective functioning of the CPU concern about the kind of CPU and workstation. Also, we can note that the desktop computing tools are very important in the embedded system. Saltzer and Schroeder made it clear that in the system design automation, more needs have to

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be meet out in the embedded system design. The tools include many, which are in the areas such as special computer design requirements, system level requirements, life-cycle support issues, business model compatibility, and design culture issues [4].

Embedded systems have limitations on both functionality and implementation. Strongin et al. emphasized that the embedded systems should confirm the real time operation reactive to external events, conform to size and weight limits, budget, power and cooling consumption, satisfy safety and reliability requirements, and meet tight cost targets [5].

2 Software Structure Model

The hardware abstraction layer can be used to encapsulate the underlying hardware information, and providing low level resources access permissions for the upper software. On this basis, the hardware abstraction layer can separate operating system in space and logic. Hardware abstraction layer and operating system, both have abilities of independent compiling, and can generate different images. The merit of the structure is: CPU core system will not easily change, only changing by the hardware interface and peripheral chips. Important operating system and application may retain the original appearance, not being installed or generated [6, 7]. While the structure has an extremely obvious disadvantage: through spatial separation, hardware abstraction layer and operating system and application of image cannot directly interface each other, must be completed by mechanism transformation.

In the embedded systems, system design is the primary importance and it is required to consider all aspects in the system design. While in designing the embedded systems, the security of the systems is considered to ensure reliability. Security issue is crucial and it contains many issues. These issues include both the hardware and the software issues; and the necessary parameters warrant attention. Normally, one cannot expect a breakdown in the hardware components; but sometime unexpected events trigger issues. In this environment, it takes many years to address, and may not be properly appreciated by non-computer engineers and managers involved in system design decisions [8]. A system can embed with environment by the control of external issues. The result is the additional advantage of reducing the amount of system wiring and number of connector-contacts by employing an embedded network rather than a bundle of analog wires [9]. This situation leads to enforce changes with respect to the problem of partitioning the computations among distributed computers in the face of an inexpensive network with normal bandwidth capabilities (Fig. 1).

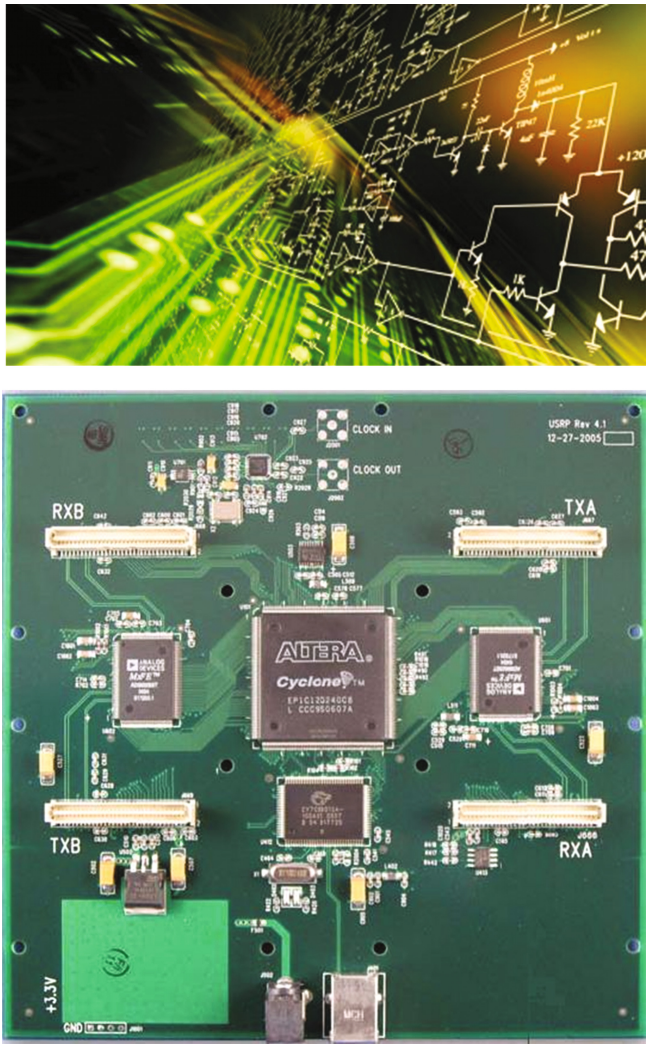

Fig. 1. The software structure model

3 Hardware Abstraction Layer Structure Model

The model structure is shown in the Fig. 2, the specific function has the following points. After completing data initialization, it starts the configuration image. With curing management image, hardware abstraction layer erases the image management and image of the load management function, and the image management module can be directly reserved device access through the device driver [10]. The hardware abstraction layer has driven all the core function of architecture equipment and chip device drivers for the operating system to provide the corresponding configuration way. Through the

debugging agent module, the hardware abstraction layer can carry on the load to the software and debugging, commissioning agency aims to connect device driver and the communication between the host end, and the correlation function image [11–13].

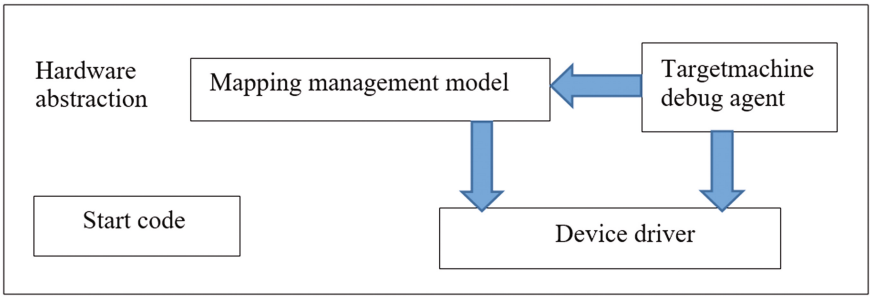

Fig. 2. The system structure of the hardware abstraction layer.

The accuracy of operation in real time systems is important and it is possible to consider the low performance some time. In a few situations, the real time operation requires to meet external 1/0 and control stability requirements. The reactive computation indicates the execution of software to external events [14]. The occurring events may be regular where the events organization ensure guarantee performance. It has been acknowledged that many embedded systems contain notable reactive components. It is found that the embedded system are physically located within some larger artifact.

4 Isolation Mechanism

At present, the domestic independent copyright operating system can completely meet the software model of the system, because the model is actually a model of the project. And this paper will use the *Vx* Works operating system for the hardware abstraction layer and the operating system isolation mechanism was studied. An embedded operating system is the most widely used systems. Wind the kernel will only have function library through the operating system layer interface function selection, and then through the system layer function library function to access the hardware abstraction layer converted BSP function, so as to realize the isolation mechanism (See Fig. 3).

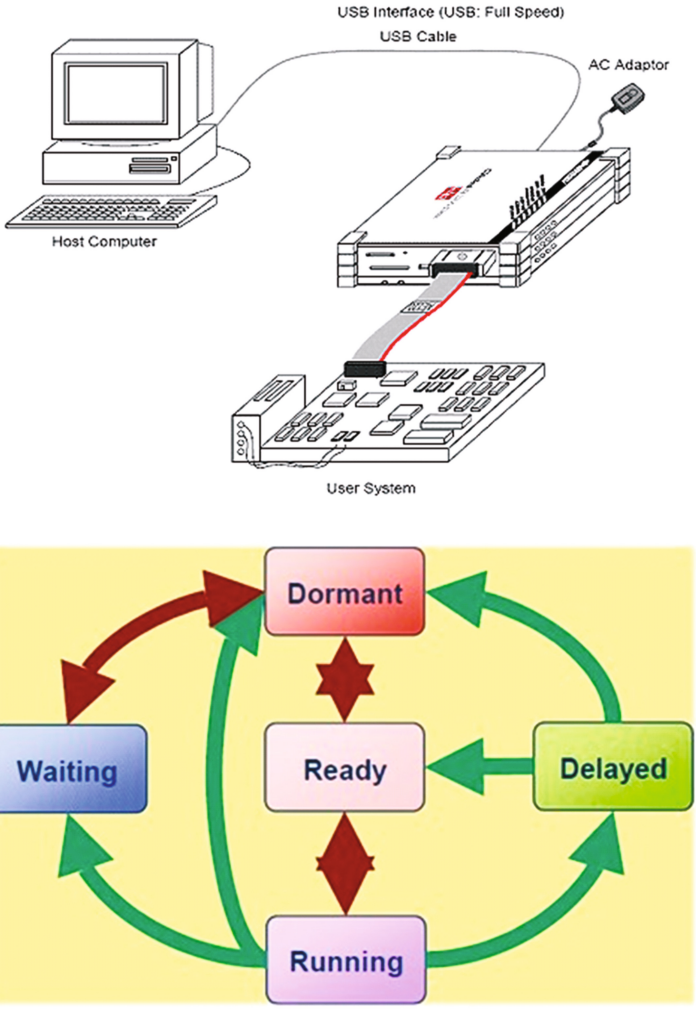

Fig. 3. Isolation mechanism

5 Verification and Test

Hardware abstraction layer and the introduction of the operating system interface to the original *Vx* Works the function of the operating system is divided into two parts, and the above has nothing to do with the hardware interface, and the other part is the software interface of the hardware abstraction layer. Direct access to the original operating system, hardware resources are changed into the hardware abstraction layer and operating system interface to access, due to software structure so revolutionary changing, the effectiveness of its function and the influence of the change in the system real-time performance will be verified and the main problems in the test. Evaluate performance

of the embedded real-time system purposed the execution time of the specific operation. Execution time measurement usually has two kinds of methods: software method and hardware method. The software method is to add timing on both ends of the tested software, software to read the record after the completion of execution of time scale to calculate; Hardware methods usually use measurement tools such as oscilloscope, the specified test points are measured by reading hardware signal waveform during the execution of a software to calculate the execution time [15]. The software method is simpler, however, time accuracy is not high; Hardware method, on the other hand, it has a measuring tool can achieve the highest accuracy of measurement, but the measurement process tends to be more complex. According to this paper the influence of operating system, we will be the main measure system initialization, interrupt response time and exception response time, by analyzing the three time metrics to add a hardware abstraction layer and operating system interface of the impact on system performance. The system initialization time measurement for accuracy is not high, using software method, the other two indicators measure methods to use hardware.

5.1 System Initialization Time Measurement System

Initialization time refers to the electricity to start from the system function *usr* Root () as the system time between the Root of the task. This article uses the *Vx* Works in the Time scale of reading function *Vx* Time Base the Get () to measure, using the Function *vx* Time Base the Get () in the implementation of the acquisition system tick, ticking the frequency of a quarter of the clock frequency of the system. This paper chooses the test platform of the system clock is 32 MHz, therefore, the frequency of the tick for 8 MHz is to remove a system call and the process of the pressure, and the stacks using the function *vx* Time Base the Get () measurement precision can reach microsecond Time, meeting the needs of system initialization Time measurement. Measured using the main code is as follows,

```
UINT32 high, low;
UINT32 high1, low1;
UINT32 high2, low2;
Vx Time Base Set (0, 0); / * counter reset * /
Vx Time Base Get (& high1, & low1); / * get start time */…
vx Time Base Get (& high2, & low2); / * System initialization code * /
high end time = high2 - high1;
Low = low2 - low1;
```

5.2 Measurement of Interrupting Response Time

Interrupting response time refers to the interruption to the system that cut off, and beginning to execute the first instruction of the interrupt service routine (ISR) last time. Interrupting response time is the important index of real-time system, and hardware method is used to measure, measuring oscilloscope accuracy which can be selected for Dana second level, ensuring the accuracy of measurement which meets the demand. Before starting the

measurement, at the beginning of the interrupting handler to add a statement, the effect is a discrete quantity of the hardware platform from 0 to 1, as a symbol of entering the interrupting handler. Then the oscilloscope channel a connection hardware platform of the interrupt request signal INQ, separating quantity signals DIO channel B connections. An interrupting occurring will trigger the oscilloscope for recording, capturing the waveform oscilloscope channels A and B, and the measurement and calculation. Using the above test method completed system initialization is that to interrupt response time and abnormal response time measurement [16]. After adding hardware abstraction layer and operating system interface, system initialization, and it interrupts response time and abnormal response time compared with before adding system which has a certain degree of increase. It is the reason why after transforming the system of a hardware abstraction layer and operating system interface function call, the timing indicators remain the same as the original level. This article takes advantage of the test environment for the Power processor PC603E. If choosing stronger processor performance, the use of hardware abstract layer of operating system interface and performance loss will be narrowed. Test results show that the hardware abstraction layer in this paper. We study and operate system interface to achieve the expectations of the design.

6 Conclusion

The current domestic study of hardware abstraction layer which relative standard has not been formed. In this paper, giving full consideration to the characteristics and requirement of embedded computer, the hardware abstraction formulates the relevant interface, so as to realize the separation of operating systems and hardware. To reform the *Vx* Works operating system, and to verify the isolation mechanism, embedded computer hardware abstraction layer and operating system interface can provide some reference for the study of experience.

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Design of Power Cable UAV Intelligent Patrol System Based on Adaptive Kalman Filter Fuzzy PID Control

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Abstract. Patrol UAV has poor aerial posture stability and is largely affected by anthropic factors, which lead to some shortages such as low power cable tracking precision, captured image loss and inconvenient temperature measurement, etc. In order to solve these disadvantages, this article puts forward a power cable intelligent patrol system. The core innovation of the system is a 360° platform. This collects the position information on power cables by using far infrared sensors and carries out real-time all-direction adjustment of UAV lifting platform through the adaptive Kalman filter fuzzy PID control algorithm, so that the precise tracking of power cables is achieved. An intelligent patrol system is established to detect the faults more accurately, so that a high intelligence degree of power cable patrol system is realized.

Keywords: Adaptive Kalman filter · Fuzzy PID · Power cable · UAV · Intelligent patrol

1 Introduction

Modern cities and enterprises all use the power cables for power transmission and distribution, and power transmission and distribution quality is affected by the running state of power cables. In order to improve power supply reliability and predict failure, cable temperature is a key indicator for fast judgment of fault points. Current power supply systems, mostly adopt temperature patrol to realize fast troubleshooting, including overload, short circuit and aging, etc.

In traditional power line patrol process, patrol work is carried out by workers and patrol conditions are recorded in paper sheets, and then the patrol conditions will be input into the computer. Therefore, the patrol data are affected by human factors; meanwhile. Whether the workers patrol the whole line cannot be effectively managed, patrol quality cannot be ensured, and the safety conditions of power lines cannot be guaranteed, which leaves security risks. Then, what kind of effective measures can be taken becomes a difficult problem for the power sector. Therefore, the development of a temperature measurement system, which is safe and stable and has wide application, has a great significance to ensure the safe operation of the power grid; this temperature measurement system can monitor the running temperatures of key points of the

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equipment in a real-time manner, grasp the running status, timely find out hidden faults, take corresponding measures and prevent further expanding of accidents [1].

Patrol UAV has poor aerial posture stability and is largely affected by anthropic factors, which lead to some shortages such as low power cable tracking precision, captured image loss and inconvenient temperature measurement, etc. In order to solve these disadvantages, this article puts forward a power cable intelligent patrol system developed based on adaptive Kalman filter fuzzy PID control algorithm. This system collects the position information on power cables by using far infrared sensors and carries out real-time all-direction adjustment of UAV lifting platform through the control algorithm, so that the precise tracking of power cables is achieved. This system uses STM32 as the control platform, uses a GPS module to collect geographic information of power cables, uses temperature logger to collect temperature data of power cables and uses a camera to capture image data; an intelligent patrol system is established to detect the faults more accurately, so that a high intelligence degree of power cable patrol system is realized. This system can directly display whether the power lines are patrolled and whether the patrol work has been completely finished, so as to meet the requirements of power line patrol in speed, efficiency and timeliness; it improves the power line patrol management to a new level and realizes the electronization, informationization and intelligence of patrol work, so as to guarantee the high efficiency, low failure rate and safe operation of power system [2].

2 System Configuration

System configuration diagram is shown in Fig. 1:

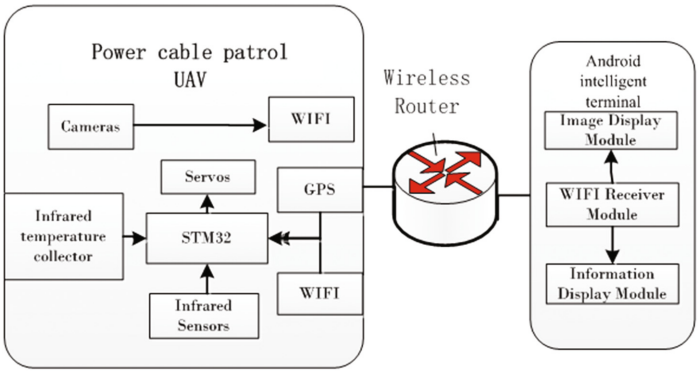

Fig. 1. System configuration diagram

The whole system mainly consists of the power cable patrol UAV and an Android intelligent handheld terminal.

① Power cable patrol UAV: Patrol workers carry out rough patrols by means of remote control. The far infrared sensor on the lifting platform acquires cable position

information and controls the platform steering engine, so as to accurately capture power cables; temperature acquisition module on the platform is responsible for temperature collection; the camera acquires image information, realizing the monitoring of the waste, oil pollutant and other faults on power cables; the wireless router is used for data transmission and exchange.

② Android intelligent terminal: The intelligent Android mobile terminal, which is developed based on the Android mobile platform and combines image and information display modules, can realize the integration of image transmission, temperature, geographic coordinates and time information, and it can monitor the patrol images and information in real-time manner.

3 Design of Key Structures of Power Cable Patrol UAV

Sensor Selection. Long-distance infrared sensor: As cable transmission will generate heat, the long-term allowable working temperature of the power cable core are 70 °C ∼ 90 °C, and the temperature of insulation layer are 20 °C to 40 °C different from cable core. The temperature of the external insulation layer is at least 30 °C according to the calculation. Considering the influence of environment temperature and the cable temperature is much higher than the environment temperature, the infrared wavelength of power cable is shorter than those of the surrounding environment. The measuring range of long-distance infrared sensor is 0 to 8 m, meeting requirement of actual flying height [3].

Infrared temperature sensor: SMTIR99XX series are thermopile-based silicon infrared sensors which can measure temperatures in contactless ways; as infrared radiation characteristics are related to temperature, filters can be used to measure different temperature ranges. Mature semiconductor process can reduce the cost and miniaturize the overall dimension at the same time. In order to meet the requirements of some certain applications, the opening angle of infrared sensor can be designed to be less than 7°. Based on the Seebeck Effect, the temperature difference can be calculated according to the analog output from infrared sensor; SMT9902 is equipped with a built-in temperature sensor which can measure the temperature of its cold end, based on which the temperature of the object to be measured can be obtained through calculation. The working temperature of the sensor itself is −40 to 100 °C. TO05 packaging is adopted for the sensor, and it has high precision, high sensitivity (110 V/W), low impedance and a measuring temperature range from −100 to 2000 °C.

Software Design. The software system flow chart of the UAV patrol system is shown in Fig. 2:

The main program of the temperature acquisition module is as shown in Fig. 3:

In the process of initialization, the definition of variables and the settings of ports and baud rate are completed. The program continuously detects whether there is a trigger signal, and only when it detects the trigger signal, will it drive SMT9902 to start temperature measurement and read temperature data. The temperature data in SMT9902 can be divided into high byte (DataH) and the low byte (DataL), and the

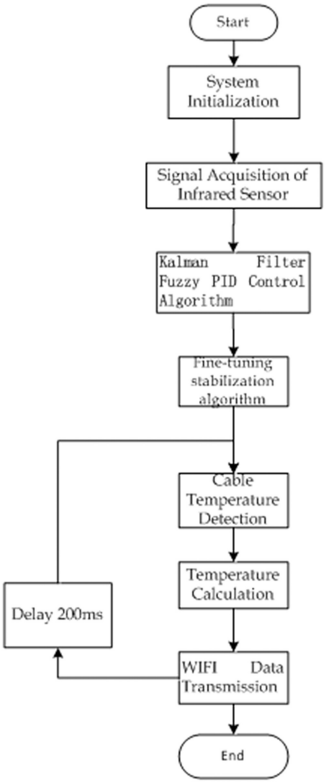

Fig. 2. Software system flow chart

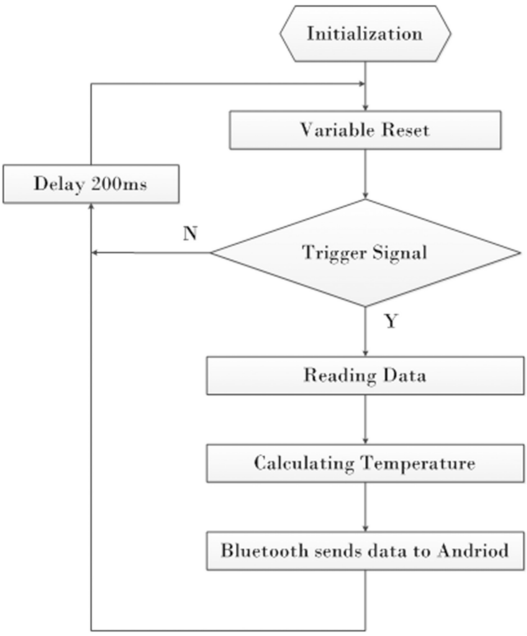

Fig. 3. Flow chart of temperature acquisition module

actual Celsius temperature can be obtained after a certain amount of calculation of the two bytes, and the calculation formula is as follows:

$$\begin{aligned} Data &= [(DataH \,\&\, 0X007F) \ll 8] + DataL \\ TempData &= [(Data \times 0.02) - 0.01] - 273.15 \end{aligned} \tag{1}$$

After obtaining the Celsius temperature, it will initiate the WIFI module transmission program, and as Bluetooth module is in series connection with Arduino, Bluetooth transmission program is the same like serial port output program [4].

Several SMT9902 can be used in one system, and different addresses are used to separate the components. Therefore, in a multiple SMT9902 system, each SMT9902 need to be allocated with an address, and the default address for components is 5AH. Data read procedures are shown in Fig. 4. The data read from SMT9902 is in byte, and the operating procedures for each byte of data are shown in Fig. 5. Each time only one byte (in bits, and 8 bits form one byte) is sent, then it will judge whether there is any response, and if there is a response, the next byte will be sent; if no, this byte will be

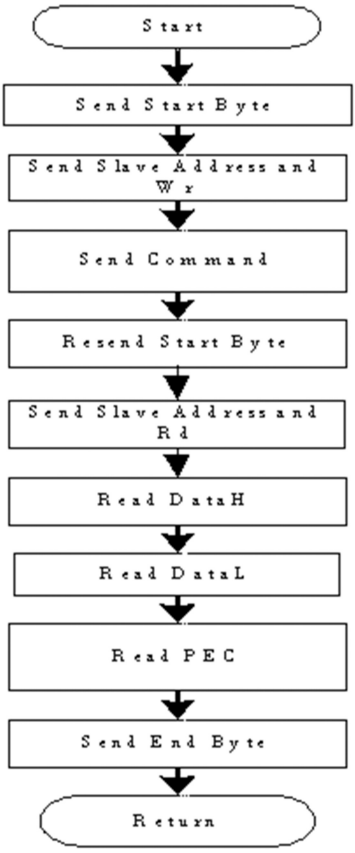

Fig. 4. Data read flow chart

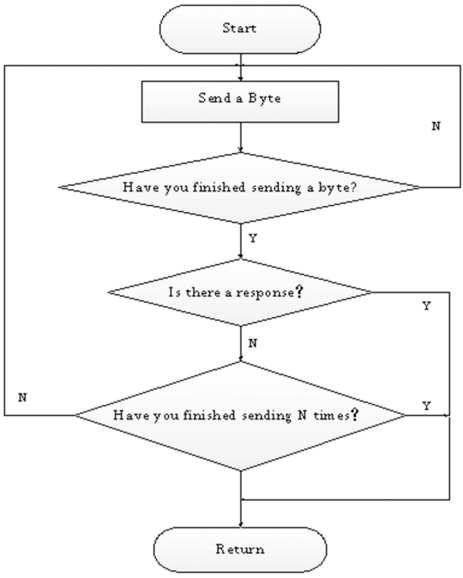

Fig. 5. Operation process of each byte of data

sent repeatedly until there is a response, and if there is no response after repeating sending the same byte for a couple of times, the will come to an end [5].

4 Fuzzy PID Control Algorithm Based on Adaptive Kalman Filter

This article puts forward a fuzzy PID control algorithm that based on adaptive Kalman filter; carry out self-learning and self-tuning for PID parameters k_p, k_i and k_d, to find out the best combination, and meanwhile it can control interference noise and measurement noise to reach the filtering effect.

The control structure is as shown in Fig. 6 [6]:

Fuzzy Adaptive Setting PID. The setting of PID parameters is a key problem in PID control. However, in actual applications, most industrial processes have different

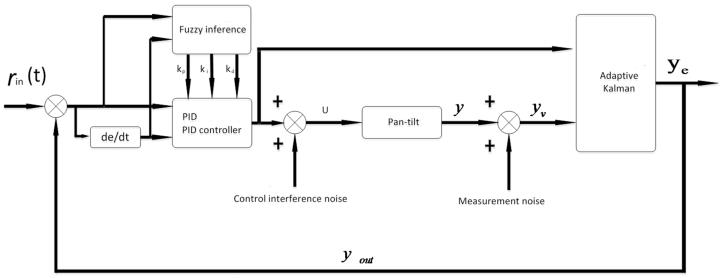

Fig. 6. Structural diagram of fuzzy PID control algorithm based on adaptive Kalman filter

degrees of nonlinear, parameter time-varying and model uncertainty; therefore, the general PID control cannot realize the accurate control of such processes.

Fuzzy adaptive PID control adopts the basic theory and method of fuzzy mathematics, and uses fuzzy set to express the conditions and operations of the rules, and it stores these fuzzy control rules and relevant information (such as evaluation indicator and initial PID parameters, etc.) into the computer knowledge base, then the computer will automatically realize the best adjustment of PID parameters by means of fuzzy reasoning according to the actual response conditions of the control system.

PID controller is a linear controller, it makes up the control deviation according to this fixed value: $r(t)$ and actual output value y(t).

$$e(t) = r(t) - y(t) \tag{2}$$

The continuous conditions of PID control law:

$$u(t) = k_p\left[e(t) + \frac{1}{T_I}\int_0^t e(t)dt + T_D\frac{de(t)}{dt}\right] \tag{3}$$

where, k_p is the scale factor; T_I is the integral time constant; T_D is derivative time constant.

Discrete conditions:

$$u(k) = k_p\left[e(k) + \frac{1}{T_I}\sum_{j=0}^{k} Te(j) + T_D\frac{e(k) - e(k-1)}{T}\right] \tag{4}$$

$$\begin{aligned}\Delta u(k) &= k_p(e(k) - e(k-1)) + k_i e(k) \\ &+ k_d(e(k) - 2e(k-1) + e(k-2))\end{aligned} \tag{5}$$

PID parameters fuzzy self-setting functions by finding out the fuzzy relationship among three PID parameters and e and e_c. It continuously detects e and e_c, and make online adjustment of the three parameters according to fuzzy control law to meet the different requirements of e and e_c on control parameters, so that the objectives can have better dynamic and static performances, as shown in Table 1.

Table 1. The relationship between PID control parameters with system performance index in time domain

Parameter name	Rising time	Overshoot	Transient time	Static error
k_p	Reduce	Increase	Minor change	Reduce
k_i	Reduce	Increase	Increase	Eliminate
k_d	Minor change	Reduce	Reduce	Minor change

In the quantitative field of input language variables: take 7 fuzzy subsets {NB NM PS PM PB NS Z}, which are Negative big, Negative middle, Negative small, Zero, Positive small, Positive middle and positive big, respectively.

Corresponding to the error e and error change rate e_c, 7 degrees are quantified as $\{-3, -2, -1, 0, 1, 2, 3\}$. Then, the membership grade of fuzzy subsets is determined, then design PID parameters according to the membership grade assignment table of each fuzzy subset and fuzzy control model of each control parameter and based on fuzzy synthesized inference, then the fuzzy control tables for setting the three parameters k_p, k_i and k_d are obtained, as shown in Tables 2, 3 and 4 [7].

Table 2. Fuzzy rule table of k_p

ec	e						
	NB	NM	NS	ZO	PS	PM	PB
NB	PB	PB	PM	PM	PS	ZO	ZO
NM	PB	PB	PM	PS	PS	ZO	NS
NS	PM	PM	PM	PS	ZO	NS	NS
ZO	PM	PM	PS	ZO	NS	NM	NM
PS	PS	PS	ZO	NS	NS	NM	NM
PM	PS	ZO	NS	NM	NM	NM	NB
PB	ZO	ZO	NM	NM	NM	NB	NB

Table 3. Fuzzy rule table of k_i

ec	e						
	NB	NM	NS	ZO	PS	PM	PB
NB	NB	NB	NM	NM	NS	ZO	ZO
NM	NB	NB	NM	NS	NS	ZO	ZO
NS	NB	NM	NS	NS	ZO	PS	PS
ZO	NM	NM	NS	ZO	PS	PM	PM
PS	NM	NS	ZO	PS	PS	PM	PB
PM	ZO	ZO	PS	PS	PM	PB	PB
PB	ZO	ZO	PS	PM	PM	PB	PB

Table 4. Fuzzy rule table of k_d

ec	e						
	NB	NM	NS	ZO	PS	PM	PB
NB	PS	NS	NB	NB	NB	NM	PS
NM	PS	NS	NB	NM	NM	NS	ZO
NS	ZO	NS	NM	NM	NS	NS	ZO
ZO	ZO	NS	NS	NS	NS	NS	ZO
PS	ZO	ZO	ZO	ZO	ZO	ZO	ZO
PM	PB	NS	PS	PS	PS	PS	PB
PB	PB	PM	PM	PM	PS	PS	PB

Adaptive Kalman Filtering. Because the lifting platform of the UAV patrol system can be affected by various environmental factors, adaptive Kalman filter is used in this paper to suppress interference noise and measure the noise so as to improve the control accuracy.

The state equation and measurement equation of the system discrete model are: $X(k+1) = \Phi(k+1,k)X(k) + B(k)U(k) + W(k), y_v(k+1) = HX(k+1) + V(k)$, of which X(k) is the state matrix, y(k) is the measurement matrix, U(k) is the control output, Φ is the state transfer matrix, B is the input matrix, H is a measurement transfer matrix, W(k) and V(k) respectively control the interference noise and measurement noise. The noise statistics are: E{W(k)} = q, E{W(k)W(j)} = Q(k), δ_{kj} and $E\{V(k)V^T(j)\} = R(k)\delta_{kj}$, where, δ_{kj} is Keluonike Function: when $k = j$, = 1, and when $k \neq j$, δ_{kj} = 0.

Due to the randomness and uncertainty of disturbance, the variance and mean of noise cannot be determined precisely. In order to estimate the mean q(k) and variance Q(k) of control interference noise W(k) and measure the mean V(k) and variance R (k) of measurement noise V(k), this article will use the maximum posteriori noise estimator sage-husa.

Algorithm steps are as follows:

(1) State estimation value in (k + 1) moment;

$$\hat{X}(k+1 \mid k) = \Phi(k+1 \mid k)\hat{X}(k \mid k) + B(k)U(k) + \hat{q}(k); \tag{6}$$

(2) Corresponding Covariance of $(k+1 \mid k)$:

$$P(k+1 \mid k) = \Phi(k+1 \mid k)P(k \mid k)\Phi^T(k+1 \mid k) + Q(k); \tag{7}$$

(3) Kalman gain:

$$M(k+1) = P(k+1 \mid k)H^T(k)\left[H(k)P(k+1 \mid k)H^T(k) + R(k+1)\right]^{-1}; \tag{8}$$

(4) New information in Kalman filter:

$$\varepsilon(k+1 \mid k) = y^{v}(k+1) - H(k)\hat{X}(k+1 \mid k) - \hat{r}(k); \tag{9}$$

(5) Optimal estimation value in (k + 1) moment:

$$\hat{X}(k+1 \mid k+1) = \hat{X}(k+1 \mid k) + M(k+1)\varepsilon(k+1 \mid k); \tag{10}$$

(6) $\hat{X}(k+1 \mid k+1)$ corresponding covariance:

$$P(k+1 \mid k+1) = [I - M(k+1)H(k)]\,P(k+1 \mid k) \tag{11}$$

(7) Use noise estimator sage - husa to estimate ω(k), Q(k), υ(k) and R(k):

$$\hat{q}(k) = (1 - d^{k})\hat{q}(k-1) + d^{k}[X(k \mid k) - \Phi(k \mid k-1)X(k-1 \mid k-1) - B(k)U(k)] \tag{12}$$

$$Q(k) = (1 - d^{k})Q(k-1) + d^{k}\left[M(k)\,\varepsilon(k \mid k-1)\varepsilon^{T}(k \mid k-1)M^{T}(k) + P(k \mid k) - \Phi(k \mid k-1)P(k-1 \mid k-1)\Phi^{T}(k \mid k-1)\right] \tag{13}$$

$$\hat{r}(k) = (1 - d^{k})\hat{r}(k-1) + d^{k}[y^{v}(k) - H(k)X(k \mid k-1)] \tag{14}$$

$$R(k) = (1 - d^{k})\,R(k) + d^{k}\left[\varepsilon(k|k-1)\varepsilon^{T}(k \mid k-1) - H(k)P(k \mid k-1)H^{T}(k)\right] \tag{15}$$

$d^{k} = (1 - b)/(1 - b^{k+1})$, $0 < b < 1$ is forgetting factor, which needs to be determined by experiment, $0.95 \sim 0.99$ is preferable generally [8].

5 The System Simulation Results

The adaptive Kalman filter fuzzy PID control algorithm in this paper is applied to MATLAB2010 for simulation, with UAV platform frame as simulation model, open-loop transfer function is: $G(s) = 16470/(S^2 + 1667S + 3393)$; sampling time t = 1 ms.

Figure 7 is the corresponding membership function:

Step signals are used as the simulation signal for the tests in this article. The comparison of image curves (as shown in Fig. 8) shows that the effects on the performance of classic PID control and fuzzy PID control are inferior to that of fuzzy PID control that based on Adaptive Kalman Filter proposed in this article. Besides, Adaptive Kalman Filter Fuzzy PID control is faster in reaching the steady state and nearly no overshoot is required.

If white noise is added, its amplitude is 0.01 (as shown in Fig. 9), two algorithms are all interfered largely, fluctuating in the stable value. However, by comparison, the algorithm used in this paper can quickly achieve the stable value, with less interference and no overshoot.

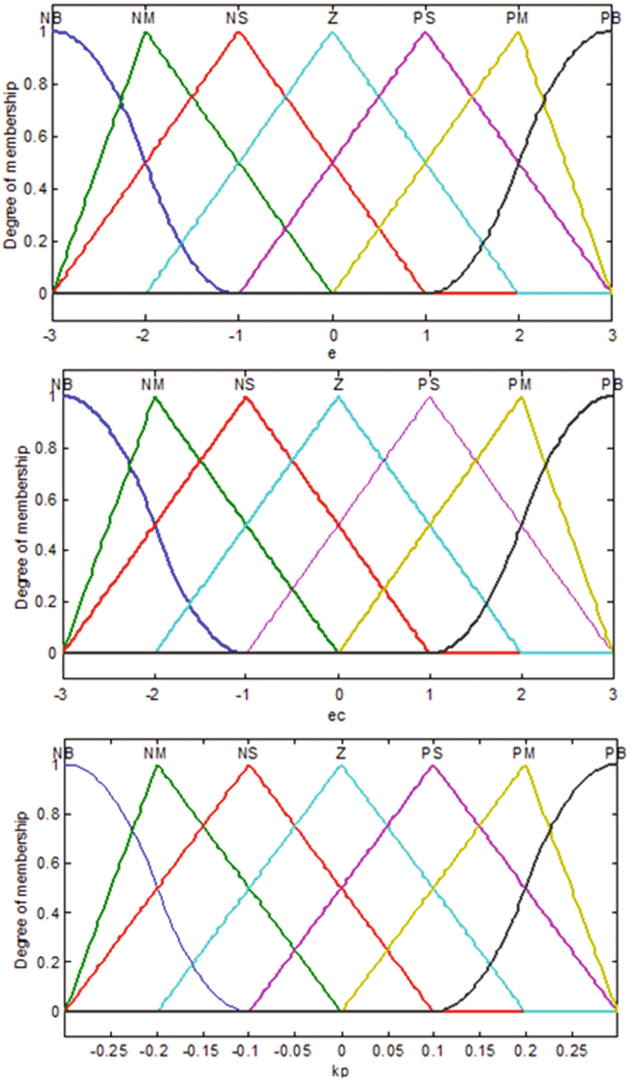

Fig. 7. Membership function of fuzzy PID

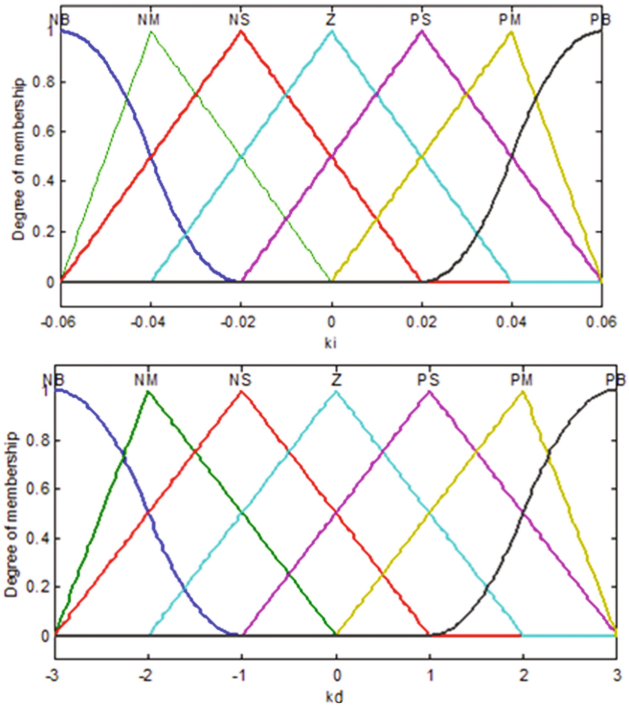

Fig. 7. (continued)

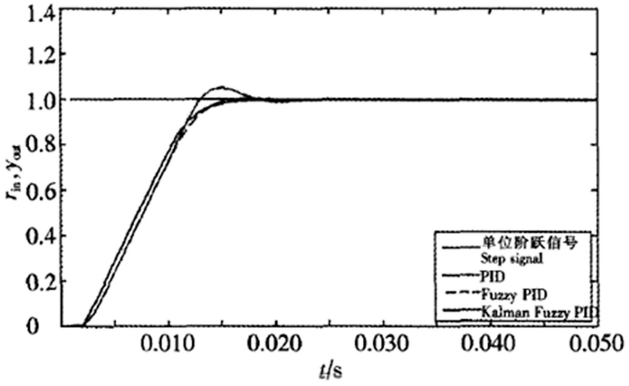

Fig. 8. Simulation results of three algorithms for sine wave with magnitude 0.01 white noise

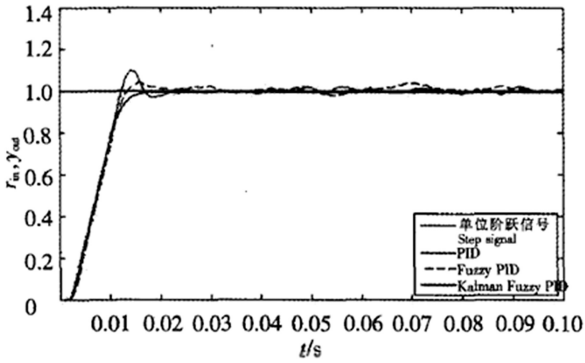

Fig. 9. Simulation results of three algorithms for step signal without noise

The sine wave simulation results show that:

① When the white noise with 0.01 amplitude is added, the classic PID and fuzzy PID all have large interference, but the algorithm in this paper can track signals fast and smoothly with no overshoot (as shown in Fig. 10).

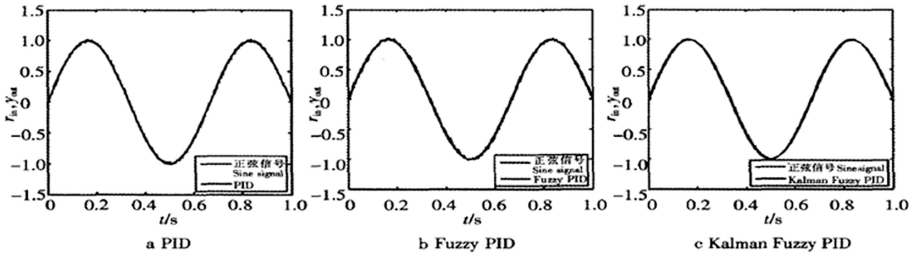

Fig. 10. Simulation results of three algorithms for step signal with magnitude 0.01 white noise

② when the white noise with 0.10 amplitude, the classic PID and fuzzy PID all have a big deviation and cannot satisfy tracking precision, but the algorithm in this paper still tracks precisely (as shown in Fig. 11).

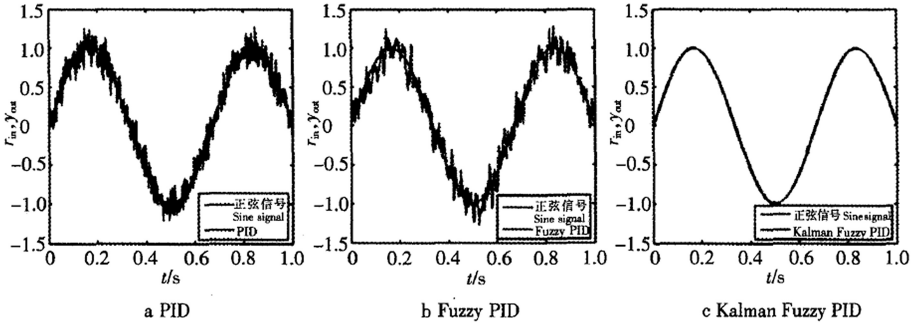

Fig. 11. Simulation results of three algorithms for sine wave with magnitude 0.1 white noise

6 Conclusion

In this article, a UAV power cable patrol system is designed, and a new algorithm of Adaptive Kalman Filter fuzzy PID control is put forward. Under the circumstance of unknown environment parameters and unstable UAV attitude, the algorithm uses infrared sensors to obtain the state of the UAV, so that the platform is controlled. In this way, the platform can precisely track the cable and make it always in the center of UAV, thus the inspection, image transmission and fault detection can be achieved. Theoretical analysis and simulation tests prove the feasibility of this kind of control algorithm. Subsequent research will be the whole set of system tests in practical operation.

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Intelligent Agricultural Machinery Monitoring System Based on the Cloud

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Abstract. Combining the advanced arm architecture and embedded Linux operating system and equipment running information test and diagnosis technology, the power of the embedded Linux intelligent agricultural machinery equipment condition monitoring system was designed and developed. The whole monitoring system is divided into two parts, the foreground and the background. 3S technology as the core of the research and development of digital agriculture spatial information management platform is a breakthrough in digital agriculture research. In recent years, supported by agricultural research information management system development has laid a good foundation. Front desk is mainly used for data collection and simple data analysis, these data for monitoring the status of the agricultural, including information, position information, state of the engine, torque converter oil temperature, brake system pressure, transmission oil temperature etc. Background to provide a powerful data processing function, used to collect the data for further analysis and processing. And these data of an effective combination of cloud technology achieve the command and dispatch of agricultural machinery and effectively achieve the monitoring of equipment operating conditions, with obvious practical and engineering application value.

Keywords: Agricultural intelligence · Embedded Linux · Intelligent monitoring

1 Introduction

With the emergence of new technologies and new ideas, especially the RISC technology and embedded technology and GuI's wide application, the combination of these techniques and modern instruments is very meaningful. At the same time, based on the embedded Linux operating system application development because of the advantages and characteristics of Linux has been a great development [1], the combination of these techniques and mechanical equipment condition monitoring is very meaningful [2]. The combination of RISC technology and data acquisition and processing equipment can greatly reduce the volume and weight of the instrument, and improve the operational accuracy of the system and the response speed of the system [3]. Will be embedded

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operation system is applied in equipment condition monitoring, will be before the execution of the order of the unified process under the operating system of management, to improve the system stability, security and efficiency also has a strong practical significance [4].

The aim of this paper is to design and develop a kind of equipment running state monitoring system based on embedded Linux, which is aimed at the shortage of equipment condition monitoring system and the use of advanced RISC technology and embedded technology [5]. And Taiwan before and after the study of the combination of equipment condition monitoring system can meet most fields of monitoring the running state of the equipment requirements, and the achieved research results have significantly advanced, practicability and economy, and engineering application value, and reached to more application in the field [6].

2 Design of Intelligent Agricultural Machinery Monitoring System

Customization and porting of embedded operating system for a specific hardware platform [7]. For the condition monitoring, in front of the system hardware design and the general embedded system is not the same place, such as the use of double CPU structure, increase the data acquisition module, these characteristics determines the system customization and transplantation of unlike ordinary embedded system as simple, which need to be considered in the system application development initial stage, according to the characteristics of the hardware system of embedded operating system for cutting and custom, and develop the corresponding driver. Information is the inevitable choice for accelerating agricultural modernization in China. Entering the 21st century, as the global economy speed up the process of integration, competition has become the focus of economic competition. Information technology has been widely applied in agriculture, and will play a very important role in agriculture and rural development [8]. The rise and wide application of information technology in agriculture, have shown the great charm of modern agriculture in 21st century, and will promote new agricultural sci-tech revolution [9].

Graphic user interface design. Including the front system of the main interface design, the interface design of each function module. In the design and development of the graphical user interface, in the development of tools, the choice of development platform and design needs to be considered, at the same time to take into account the cost of system development and system GUl can be upgraded [10]. According to the characteristics of the portable instrument, the design of the front desk of the GUI to interface aesthetics, easy human-computer interaction. As shown in Fig. 1.

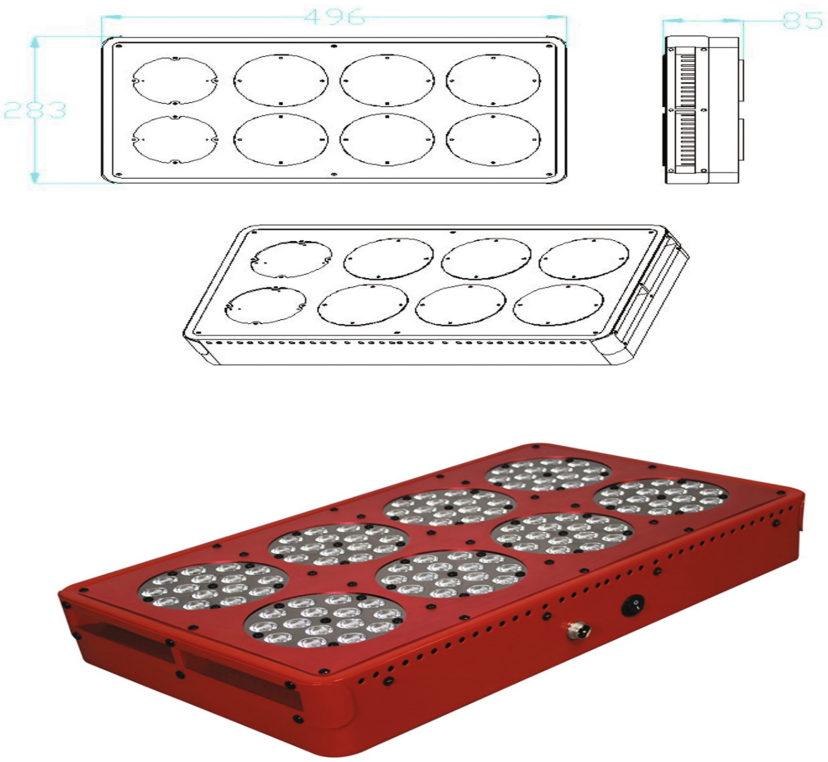

Fig. 1. Agricultural machinery monitoring system

According to the functional requirements of the system and the target, the software system design, mainly signal acquisition program design, signal analysis function program design, data management program design, etc.

The front collecting data to files stored in flash in front of the system, the data often need to send to the background for further analysis and processing, the reasonable design of the data management mode and data transmission mode is the data management system is the key. Support the agricultural data of digital agriculture, construction, and most of the agricultural data are based on the spatial distribution of agricultural resource distribution over a wide geographical space. Agricultural production was fought on a wide geographical and spatial information technologies in the field of agriculture has been more and more used. Using information technology to develop digital agriculture spatial information management platform, will solve the problems of resources and environment. Promoting agriculture and sustainable rural development plays a very important role. As shown in Fig. 2.

Fig. 2. System data management

According to the "JTT808-2011 Agreement" (the Ministry of Transport, Ministry of Transport Vehicle Terminal Industry Standard), relevant information data are sent to the cloud platform. This paper starts from the relation of digital agriculture and agriculture information, demonstrates the digital agriculture spatial information management. The theoretical basis; Proposed digital agriculture spatial information management platform and technology base; Build platform for digital agriculture spatial information management framework and key technology system; Agricultural information system based on Web safety control case; Introduced a standard system of digital agriculture and agriculture information classification and coding standards; Combined with the practice of agriculture, modern agriculture Park in Shanghai, launched a model study on application of digital agriculture spatial information management platform. Which digital agriculture spatial information management system framework and key technology system of agriculture information classification and coding standard development, agricultural information security control based on web cases achieving application and demonstration base of spatial information management platform is all featured in this article.

3 Signal Transmission and Processing Optimization Technology

The poor operating environment of agricultural machinery and the wireless signal difference in the field, an improved filtering communication method under the interference environment of the improved wavelet algorithm is proposed. The traditional algorithm only has simple filtering processing to the transmission signal, which ignores the inherent correlation of the noise signal and the problem that the partial hiding noise can not be eliminated. And basis in the interference environment periodic communication sequence formed under interference environment of communication model, communication process containing noise signal separation problem is transformed to an over determined blind source separation problem, using wavelet packet decomposition principle, multi frequency division communication frequency band, there will be no division of the high frequency data of careful decomposition, communication filtering, noise elimination, to the quantization of wavelet packet coefficients by soft threshold value

and the fixed threshold value, the processing of wavelet packet coefficients to reconstruct the denoised signal, accurate realized communication interference environment of the filter. Improved wavelet algorithm in the interference environment of the filtering communication denoising effect is good, strong robustness. Specific steps are as follows. Sign-wave signal with bandwidth, fiber transmission loss characteristics in signal processing for high frequency microwave signal provides greater delay. Optical microwave signal processing theory based on digital signal processing theory, but compared with the traditional microwave signal processing technology, despite the need for the introduction of additional PV and electro-optical processing, using Photonic devices for sign-wave signal processing can provide the sampling rate of the signal processing and electro-magnetic interference. Microwave Photonic technology of the high frequency microwave signal can be filtered, frequency converter, a/d conversion functions. In particular to generate and transmit microwave signals in optical fiber systems, microwave Photonic filters, such as microwave Photonic frequency conversion technology undoubtedly makes the system by introducing a more perfect. As shown in Fig. 3.

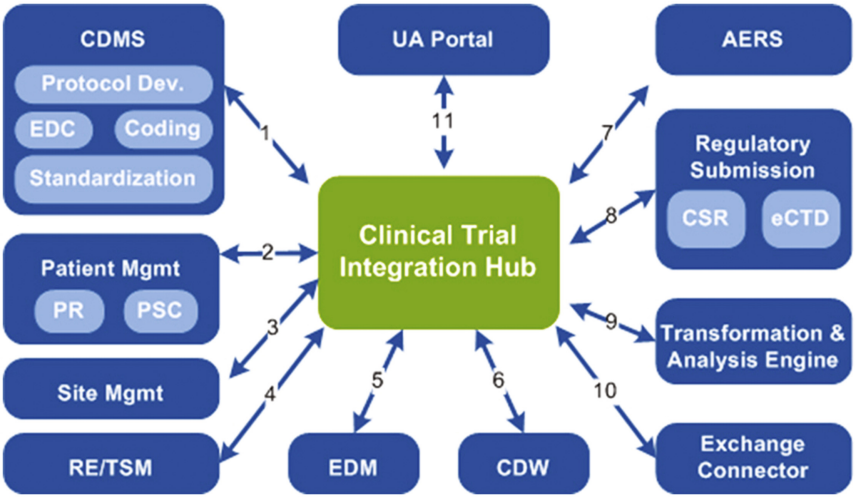

Fig. 3. Agricultural machinery

Step 1. In the process of optimizing the filtering communication in the interference environment, assuming that $f(t)$ is represented in the communication process, the discrete signal is detected, and the $l_0^1(t)$ signal is represented by a total of $2j$ wavelet packets on the j layer, and the position of the $2j-1$ wavelet packet is in the $j-1$ communication layer, which can be calculated by the convolution of the i wavelet packet and the H representative of the wavelet decomposition filter. The position of the $2i$ wavelet packet is the same as the position of the $2i-1$ wavelet packet, and the wavelet packet can be obtained by convolution calculation with i wavelet packet and G wavelet decomposition filter. The above description can be drawn under the type,

$$\begin{aligned} l_{0}^{1}(t) &= f(t) \\ l_{j}^{2i-1}(t) &= \sum_{m} H(m-2t) l_{j-1}^{1}(t) \\ l_{j}^{2i}(t) &= \sum_{m} G(m-2t) l_{j-1}^{i}(t) \end{aligned} \tag{1}$$

The $l_j^i(t)$ represents the i wavelet packet coefficients on the communication layer of the j layer.

Step 2. In the interference environment of filter in the communication process, select best basis, using calculated in communication system in each node of entropy.

$$E(S) = -\sum_{i} s_i^2 \log(S_i^2) \tag{2}$$

Step 3. In the interference environment of optimal filtering in the process of communication, communication filtering denoising by wavelet soft thresholding, the soft to clarify the value and the fixed threshold value to the quantization of wavelet packet coefficients, the type of communication system is established in the fixed threshold criterion.

$$thr = thr \cdot s \tag{3}$$

$$hr_2 = \sqrt{2\log(n)} \tag{4}$$

$$s = \frac{median}{0.6745} \tag{5}$$

where n represents the length of the communication signal, and s represents the robust estimation of the wavelet coefficients of each detail.

Step 4. In the interference environment of filter in the process of communication, wavelet coefficient absolute value and setting threshold, will be less than the threshold of wavelet packet coefficient of 0, will be greater than or equal to the threshold of wavelet packet coefficient is defined for both the error value.

Step 5. In the process of filtering communication in the interference environment, the communication signal is reconstructed by using the processed wavelet packet coefficients,

$$l_j^i(t) = \left| 2\sum_{m} h(t-2m) l_{j+1}^{2i-1}(t) + \sum_{m} g(t-2m) l_{j+1}^{2i-1}(t) \right| \tag{6}$$

In summary, we can show the principle of filtering communication under the environment of interference, and then effectively complete the filtering communication.

4 System Monitoring and Scheduling

In order to make the agricultural machinery management department to grasp the operation status of the remote operation of agricultural machinery in a timely manner, must carry on the command and dispatch to the agricultural machinery, simultaneously provides the transportation and the service information for the driver. Mainly used in the following aspects.

4.1 Agricultural Machinery Monitoring and Dispatching System

Agricultural machinery management department can use the vehicle monitoring system for agricultural machinery monitoring, and timely adjustment of agricultural machinery operation, to achieve effective management.

4.2 Emergency Assistance System

The GPS positioning and monitoring management system can help the agricultural machinery in the event of danger or accident. The electronic map of the monitoring station can display the help information and the warning goal, plan the best aid scheme, and remind the duty personnel to carry out emergency treatment.

4.3 Accident Analysis System

Using GPS information to be preserved in the system, there will be the danger of accident reappear, managers can according to the time of agricultural machinery driving route, direction, speed, and that the cause of the accident danger, to speed up the dangerous accident confirmation and processing.

5 Conclusion

In this paper, on the basis of signal analysis and equipment condition monitoring technology, embedded system and embedded Linux technology applied research, the development of the embedded Linux intelligent agricultural machinery, equipment condition monitoring system based on and cloud technology combined the application in actual production, has great theoretical value and practical value.

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The Application of Artificial Intelligence in Financial Evaluation

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Abstract. Artificial intelligence is a new subject which has been applied in many fields. With the rapid development of China's market economy, more and more investors participate in the stock market, which they hope to share the fruits of economic growth through equity investment. Under such circumstances, people like to evaluate the financial to gain more financial income. Although, the human trader is more rational than the machine when doing a comprehensive analysis. But there are too much data and information in this economic subject. It is hard for people to figure it out all by manual. So they try to apply artificial intelligence in this field, especially financial evaluation. In this paper, we will use the Shanghai Composite Index as a representative of the financial community, using macroeconomic indicators and artificial intelligence methods to predict the trend of the stock market. The application of artificial evaluation will be helpful to analyze the financial data more accurately in daily times.

Keywords: Application · Artificial intelligence · Financial evaluation

1 Introduction

Thanks to the arrival of the era of artificial intelligence, which helps to solve the asymmetric information problem between financial institutions and ordinary people. Traditional finance cannot get the user's information, but the artificial intelligence technology can use such data to build a credit model. For instance, Internet companies and data companies can collect the data of users online, and rank their credit rating after analyzing and forecasting the data, such as the user's age, income, occupation, education, assets and liabilities. If there is no efficient, safe and compliance of the data access system, then intelligent algorithms and models are inefficient. Besides, there are some other relevant data, such as the searching information and habit online and behavior data [1]. Artificial intelligence in the field of health care, marketing, business analysis and financial services, there are many applications, these areas are the most intensive data industry. Data is the lifeline of artificial intelligence.

The basic layer of cloud computing, big data and other factors had promoted the progress of artificial intelligence algorithm and make a breakthrough. Such complex task classification accuracy is significantly improved, thereby promoting the computer vision, machine learning, Natural Language Processing, robot technology and speech recognition technology.

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It is because of self consciousness, we will think for themselves. These consciousness leads to our conscious or unconscious intervention in the financial markets, so that it is in the direction of their own favorable development. Of course, not all of the interventions are bad, and not all of the intervention can be immediate. In the end, the effect of human intervention in the market and how to take effect is not easy to estimate, regardless of the machine and people.

Just think about the weather forecast, the current weather forecast is to use the principle of big data to do. Weather forecasts are rarely affected by human factors, so it is still difficult to achieve a very accurate prediction. When someone interferes with the weather, you can imagine what the weather forecast will be like.

Artificial intelligence is used in financial evolution not only change the financial investment environment, but also personal financial capacity. As we all know, only few people can get in touch with financial investment advisors in their lives, and most people cannot invest wisely because of asymmetrical information, they have no means to get professional information and enough capacity to deal with these data. But when the artificial intelligence technology applied to the financial evolution, people can use the technology to design the parameter and the relationship spectrum in advance to build the risk quantitative data model and carry out the risk assessment [2].

Firstly, once artificial intelligence used in financial evolution, it can provide financial services to all groups of the society efficiently. In fact, artificial intelligence can make all people enjoy more financial services and through this way people can know the finance more clearly and make more money. Today, more and more people have built up their senses of financial management [3].

Secondly, artificial intelligence used in financial evolution not only change the financial investment environment, but also personal financial capacity [4]. As we all know, only few people can get in touch with financial investment advisors in their lives, and most people cannot invest wisely because of asymmetrical information, they have no means to get professional information and enough capacity to deal with these data [5]. But when the artificial intelligence technology applied to the financial evolution, people can use the technology to design the parameter and the relationship spectrum in advance to build the risk quantitative data model and carry out the risk assessment [6].

The left part of the article is organized as follows. Section 2 will introduce the state of the art, including the artificial intelligence and its application in financial evaluation. Section 3 will show the readers the method to study the relation between macroeconomic variables and the Shanghai Composite Index through artificial intelligence. Section 4 will analyze the result. Section 5 will be the conclusion.

2 State of the Art

Artificial Intelligence is a new technology to study and develop the theory, method, technology and application system for simulation, extension and expansion of human intelligence [7]. Artificial intelligence is a branch of computer science. In order to understand the intelligence essence and produce an intelligent machine which react like human beings. The research in this field has become more and more mature.

The application of this technology is also expanding. Since the cognition of artificial intelligence must rely on big data to achieve, then the more data, the final result is closer to reality [8]. However, all the big data collected from the past which is a summary of the past. These data may be similar in the future, it may be completely different from the actual situation in the future. After all, the factors affecting the future changes are changing [9].

In the past few years, people should complete the scientific and engineering calculation all by themselves. And now the computer can not only complete the calculation, but also can complete the job more efficiently and accurately [10]. Since then, human no need to complete a complex task, showing that the definition of complex work is changed along with the timely development and the technical progress [11]. With the development of science, artificial intelligence finally be applied in finance, which is more meaningful and difficult and cause high attention [12].

Google, IBM and other international giants have artificial intelligence technology in all kinds of aspects of penetration, on the whole, the domestic financial industry is also gradually began to promote the application of artificial intelligence technology, with the domestic double policy and investment pull on the artificial intelligence industry, it will be widely used in the future [13].

The artificial intelligence research has two main characteristics: one is in the leading position in the field of vision, speech recognition, which is mainly a few big companies better, visual recognition is the entrepreneurial team achievements. In deep learning, core algorithm, unmanned research. The other two are due to funding for human and other reasons, the domestic research on artificial intelligence showing a "enterprise based, supplemented by research institutions, cooperative enterprises and research institutions".

Nowadays computers can not only complete the calculation, but also can complete the job more efficiently and accurately. With the development of science, artificial intelligence finally be applied in finance, which is more meaningful and difficult and cause high attention. In the long term, the application of artificial intelligence in the financial evaluation will soon be increased. However, due to the basic research limitations, the technology itself is difficult to face the complex financial markets alone. Human and artificial intelligence systems will be the leading roles in the future of the financial evaluation and market. Here's a picture of the financial transaction site (See Fig. 1).

The financial sector as the head of all trades, there is a huge network intertwined with the whole society, precipitated a lot of useful or useless data, including various types of financial transactions, customer information, market analysis, risk control, investment consulting, data level is a massive unit, and large amount of data is non structured form. Such as identity card scanning customer information, not only occupy storage resources, there are duplicate storage, waste valuable, and cannot turn into the analysis. And financial big data processing work is facing great challenges. The learning system through the use of artificial intelligence in depth, to have enough data for learning, and constantly improves and can even exceed the human knowledge, ability to answer, especially in the aspects of risk management and transaction processing of complex data, the application of artificial intelligence will greatly reduce labor costs and improve financial risk control and business processing ability. Here's a picture of the scene of the stock market (See Fig. 2).

Fig. 1. Financial transaction site

Fig. 2. Scene of stock market

3 Methodology

According to the above mentioned, we can conclude that the relationship with the financial information, management system based on artificial intelligence.

The financial model is according to the regression analysis to make an impact analysis of data by using the formula of the collected data, according to the formula of the data into an application can be predicted, in the stock market is to predict the market price.

And first, we would like to introduce some assessment method. Statistical learning theory is derived from the traditional machine learning which can be described as: through the given input and output samples, according to a certain learning method, the model will try to find out the internal relations between the input and output, the mapping relation, which can forecast the unknown output as accurate as possible.

The mathematical form of machine learning is expressed in the form: given several independent and identically distributed observation samples. And the target of statistical learning is to find out the optimal function to describe the relationship among the samples and make the expected risk function at its minimum:

$$R(w) = \int L(y, Q(x, w) dF(x, y)) \tag{1}$$

For the problem of pattern recognition, the loss function is defined as follows:

$$L(y, f(x, w)) = 1, y \neq f(x, w) \tag{2}$$

Although different data have different loss functions, the purpose of machine learning is to make the risk minimization, and help the application of artificial intelligence in financial evaluation play a guiding role.

In the process of financial forecasting, this article chooses the main macroeconomic indicators as input variables to reflect the financial situation. And then select the input variables of the model after a simple analysis of the alternative indicator, and the closing price of the Shanghai Composite Index as output variable. The Single step prediction will be used in the process.

4 Result Analysis and Discussion

The model samples are selected from 2005 to 2011 monthly macroeconomic indicators data and Shanghai index closing price. The correlation coefficient between macroeconomic variables and the Shanghai composite index are as follows (Table 1):

From the table data we can draw the conclusion that the many economic factors have significant correlation with the Shanghai Composite Index. What's more, the lag index, early warning index and the consumer price index and the Shanghai Composite Index have significant correlation, and import & export volume, M2 growth rate and industrial ex factory price index and the Shanghai composite index correlation is not strong. The linear correlation coefficient is used to measure the linear relationship between the two variables, but cannot measure the nonlinear relationship among the variables. In this case, the rank correlation coefficient can be used instead of the linear correlation coefficient. As long as there is a monotonic functional relationship between

Table 1. Correlation coefficient between the macroeconomic variables and the Shanghai composite index

Macro variables	Leading index	Consistent index	Lag index	Warning index	PMI	Import & export increased	CPI
Correlation coefficient	39.63%	34.04%	46.54%	53.81%	27.43%	9.1%	53.49%
Macro variables	Interbank offered rate	M2 growth rate increased	Fixed assets growth	Price of industrial products	New loans increase	RMB US dollar Exchange rate	Finance growth
Correlation coefficient	20.27%	8.1%	−18.43%	5.78%	26.92%	−23.71%	33.63%

Table 2. The coefficient of rank correlation between the macro economic variables and the Shanghai composite index

Macro variables	Leading index	Consistent index	Lag index	Warning index	PMI	Import & export increased	CPI
Coefficient of rank correlation	51.61%	55.17%	45.40%	69.9%	33.53%	13.29%	52.30%
Macro variables	Inter bank offered rate	M2 growth rate increased	Fixed assets growth	Price of industrial products	New loans increase	RMB US dollar Exchange rate	Finance growth
Coefficient of rank correlation	14.45%	11.22%	−28.91%	9.1%	51.35%	−25.65%	53.14%

the two variables, so they are rank related. The coefficient of rank correlation between the macroeconomic variables and the Shanghai composite index are follows (Table 2):

From the table above, rank correlation coefficients show that the Shanghai stock index and macroeconomic variables have a strong correlation. And compared with the linear correlation coefficient, rank correlation coefficients between macroeconomic variables and the Shanghai Composite Index have improved apparently, showing that the Shanghai stock index and macroeconomic variables have a strong correlation. Including the growth rate of M2, the factory price index of industrial products and the Shanghai Composite Index.

5 Conclusion

The emergence of artificial intelligence helps to solve the asymmetric information problem between financial institutions and ordinary people. At the same time, artificial intelligence has been applied more and more widely in financial sector especially in the financial sector. It can help to forecast the trend in the stock market. With the development of the economy, domestic financial institution has been more and more affected by the macro economy. One thing worth mentioning is that it can help to forecast the trend in the stock market. People all thinking highly of this function. Under such a background, in this paper, we will use artificial intelligence and macroeconomic indicators to forecast the Shanghai Composite Index in the future through its monthly closing price trend, and find out the relation between the macroeconomic indicators and the Shanghai composite index. According to the experimental data, we can know that the rank correlation coefficient can explain the relationship between macroeconomic variables and the Shanghai Composite Index more accurate than linear correlation coefficient. For the financial industry, the most important is to continue to closely follow the trend of artificial intelligence, trying to use the relevant technology. Such as to enhance the customer experience or internal management efficiency, or risk prevention, attract more people to join this new area.

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Research on Agricultural Intelligent Robot Based on Path Planning

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Abstract. Based on research and application of agricultural robot's path planning and autonomous navigation, this paper proposed path planning proposal relied on genetic algorithm, which programmed and calculated some elements, such as target identification, image segmentation and two dimensional grid map of rough sets technology. Through the test, it was observed that harvesting robots can efficiently segment and extract ripe fruits. Besides, it can complete multi-goal tasks. It was proved by practice that rough sets genetic algorithm can obviously improve the speed of path planning. Benefit from it, the efficiency of harvesting task can be promoted as well.

Keywords: Agricultural intelligent robot · Path planning · Integrated design

1 Introduction

Harvesting robot stands for the advancing front of agricultural high and new development, which plays a vital role in agricultural scientific research. The visual system of robot is the key link in designing intelligentized and move-autonomously robot. Additionally, it's also the base for robot to finish autonomous path planning, which has great influence on the research. Nowadays, method of robot path planning varied. For instance, path planning based on genetic algorithm does well in searching, but it takes long time to plan path, which is hard to meet the requirement of working in a complicated environment, especially real-time performance in a dynamic environment. Although many efforts have been spared to improve this method, yet the outcome isn't pretty good. In order to solve the problem, this paper raised rough sets with the help of a robot genetic algorithm of global path planning and making dynamic and real-time performance of robot path planning come true [1, 2].

Harvesting robot research began in the late 60s. Nilssen Nils and the Stanford Institute (SRI) Rosen, Charles and others, in 1966–1972 in the development of an autonomous harvesting robot named Shakey [3]. The purpose is to study the application of artificial intelligence technology in the autonomous reasoning, planning and control of the robot system in complex environments. At the same time, the operation of the first type walking robot is successfully developed, and thus began the research on the robot walking mechanism, in order to solve the problem of uneven movement of robots in the

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region, design and manufacture of a multi legged walking robot [4]. One of the most famous is called the Electric Quadruped General walking robot. At the end of 70s, with the application of computer and the development of sensor technology, the research of harvesting robot has emerged a new climax. Especially in the mid 80s, the design and manufacturing of the robot wave swept the world. A large number of world famous companies started to develop harvesting robot platform, the mobile robot is mainly used as the university laboratories and research institutions, the mobile robot experimental platform, so as to promote the emergence of harvesting robotics research direction. Since the 90s, the environment information sensor and information processing technology development of high level, high adaptability of harvesting robot control technology, programming, technology under the real environment as a symbol, to carry out higher level research of harvesting robot [5].

Intelligent computing, as a special method for solving the nonlinear problem has attracted widespread attention, it is meant or method to acquire and express knowledge, and simulate a subject intelligent behavior. Before the path planning method of a mobile robot based on Intelligent Computing, people have realized that the complex practical problems require an intelligent system to combine the knowledge, technology and method of different sources [6]. It is expected that these intelligent systems have special knowledge like a human in a certain field, can self adjust and learn to do better in the changing environment, and make decisions and to explain how to take action. At present, the most active three areas of intelligent computing are: fuzzy logic, artificial neural networks, evolutionary computation, and the combination of the three and mutual penetration [7].

At present, fuzzy technology, neural network technology and genetic algorithm, simulated annealing algorithm penetration and collaboration has been a doubt of the development direction. As intelligent information processing or information processing technology to the calculation of four important in the field of intelligent and energetic, they need to be combined with each other and mutual promotion in the process of its application and further development [8].

2 Algorithm Integrated Design of Harvesting Robot Path Planning

The first step for harvesting robot to plan path is to make out a route decision table based on target-fruit image. However, the data of route decision table are pretty huge, hence it needs to be simplified by certain condition attributes and decision attributes of algorithm table, namely a decision table is greatly simplified by wiping off superfluous data. Path planning algorithms for the system design frame is as Fig. 1.

In Fig. 1, it needs to make out decision table based on fruit image recognition, then preliminary simplify decision table and training sets and attributes, moreover, it's required for a simplified decision table using rough set and decision table having been simplified will be sampled data, and the training sets of genetic algorithm. Information exchange between genetic algorithm and rough sets algorithm adjusts decision rules of each training set. Further, it will optimize algorithm until a total sample of training sets is classified correctly [9].

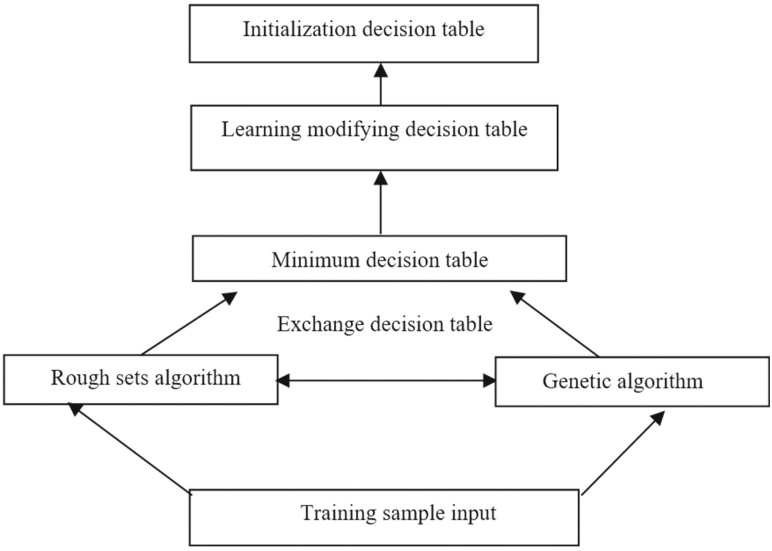

Fig. 1. Path planning algorithm for designing frame system.

Based on dealing with and tracking target image in practical environment path planning, rough sets and genetic algorithm optimize robot path planning. Since the direction of robots and fruit are unknown in the working environment of harvesting robots [10]. It uses a color camera which can quickly focus on the pint and does well in aligning to make robot recognize harvesting fruits clearly and widen eye-reach. Besides it, this kind of color camera can harvest fruits in a large scale. The camera equips at the performance end of harvesting robot. Fruit target image gathering from camera can't be used by the system immediately. It needs digital integration. Taking advantage of capture card digital transformation can be completed, which allows to gather fruit image. By this output system can recognize digital data and save them on computers (See Fig. 2), which makes them to be modifiable and manageable image informative data [11].

With the help of a capture card real-time acquisition of image can be a reality and through control bus information transmission between acquisition card and PC can come true. The image output of acquisition card is RGB color model. Before processing, image it needs to have a color model transmission, and transform it to be a HVS color space model [12].

Path planning is one of the basic links of autonomous mobile robot navigation. It is according to a certain performance index. An optimal or nearly optimal collision free path from the initial state to the target state [13]. According to the different environment of robot to know the information degree, can be divided into two types: one is global path planning is fully aware of the environmental information; environmental information is a completely or partly unknown, detected by sensors on the robot work environment, local path planning in order to obtain information on obstacle location, shape and size etc.

Fig. 2. Application of agricultural robot.

Global path planning consists of two sub problems: environmental modeling and path searching strategy [14]. Among them, the main methods of environmental modeling are: Visual Graph method, Space Approach Free method and Grids method, etc.

The Visual Graph method to the robot to a point, the vertex robot, target point and polygon obstacles are combined and connected between the robot and the obstacles, for each vertex of the target point and the obstacles of each vertex and each obstacle vertex and vertex connectivity are not through obstacles, that line is visible [15]. The problem of searching the optimal path is converted to the shortest distance from the starting point to the target point through these visual lines. Using the optimization algorithm, can remove some unnecessary connection to simplify the visual map, shorten the search time. This method can achieve the shortest path, but if the size of the robot is negligible, so the robot through the obstacle vertices from obstacles too closes contact and even a long time to search for the N line, the search time is O (N2).

Voronoi Diagrams method and Tangent Graph method improve the Visual Graph method; Space Approach Free method in robot path planning, such as using predefined generalized convex polygon cone and the basic shape of free space, and Space Approach Free for a connected graph for path planning graph through search. This method is more flexible, the starting point and the target point of the change will not cause the reconstruction of connected graphs, but the number is proportional to the complexity of the algorithm and the obstacle, and is not under any circumstances can obtain the shortest path [16].

Grids method will work environment of the robot is decomposed into a series of values with two grid unit information; use the four binary tree representation working environments. Through the optimization algorithm to complete the path search [17]. The unit to record information in a grid environment, the environment is quantized into a grid with a resolution of the grid directly affects the size of the environmental information storage size and planning based on the path planning method of mobile robot intelligent computing the length of. Large grid, environmental information storage capacity is small, the planning time is short, but lower resolution, in a dense environment reduces path capacity; small grid environment, high resolution, strong capability of path discovery in a dense environment, but the environment information storage, planning a long time, you can make up for deficiencies in the grid using the improved Grids method [18].

Harvesting path optimization mainly maintains obstacle avoidance and optimal path searching. In order to realize this goal, it needs to search path algorithm based on image segmentation and processing technology along with rough set and genetic algorithm. Therefore the grid model of initialization decision table establishing robot path planning is as Fig. 3.

When moving robot to Pi, there will be eight direction for nest step. Quantifying the eight direction, there will be C = {X1, X2, X3, X4, X5, X6, X7, X8}. According to direction quantification, initialization decision table can be established. Assuming 1 stands for grid obstacle, 2 stands for free grid and X stands for decision attributions. Initialization decision table would be as Table 1.

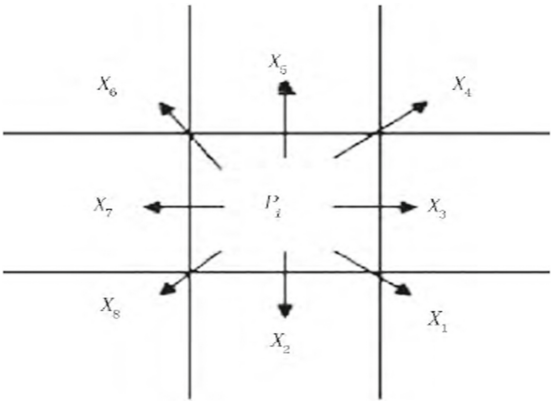

Fig. 3. The moving path grid of harvesting robot.

Table 1. Initialization decision table.

A	X1	X2	X3	X4	X5	X6	X7	X8	Y
1	2	2	2	1	1	1	1	1	1
2	2	2	2	1	1	1	1	2	1
3	2	2	2	1	1	1	1	3	1
4	2	2	2	2	1	1	1	1	1
5	2	2	2	2	1	1	1	2	1

Relying on rough sets algorithm, same decision types can be removed, namely remove redundant data. Optimizing rough sets algorithm, minimum decision is reached. After rough sets, training, the initialization decision population obviously decreases, which guarantees to improve the efficiency of genetic algorithm on the base of maintaining feasible solution. In the process of optimizing path. If merely using the length of path as standard, it can't reach the optimum result. So the fitness function needs to be introduced, namely

$$f = \left(1 + \frac{1}{\sqrt{n+1}}\right) D \tag{1}$$

Among them, n stands for the number of grid, and D stands for the sum of linear distance between adjacent sequence number when operating as a genetic algorithm correction factor need to be introduced. According to the practical environment of fruit harvesting, robots identify target fruit, make out decision table, simplify decision table with the help of a rough set algorithm, and then choose the optimum path as genetic algorithm based on image segment technology.

In order to verify the robot's reliability of fruit autonomous recognition and autonomous path planning harvesting robot performance test aims in designing in this paper, including image processing performance and path recognition performance. Meanwhile,

integrating rough sets and genetic algorithm, it processes programmable control for robots.

In order to visually display the reliability of the rough sets algorithm it uses C++ programmable method to test rough sets algorithm performance. Trough test it's observed that using rough sets can greatly decrease the number of needed training population and average iterative times. It doesn't deed CPU - clock unit, which greatly improves algorithm performance of the robot. It processes rough sets genetic algorithm and general genetic algorithm test on the condition of increasing the complexity of obstacle and other parameters keep the same. It's proved that using rough sets genetic algorithm effectively to improve the speed of path planning, which greatly improved the harvesting efficiency of harvesting robots.

3 Conclusion

This paper, processed test for the performance of harvesting robot, including the ability of fruit image extraction and recognition as well as path planning. Through the test, it's proved that the robot visual system can efficiently finished fruit image extraction and recognition as well as path searching and planning. Meanwhile, it takes less time and decrease the average iteration number to use genetic path planning with rough sets, which not only improves the harvesting, working efficiency of harvesting robots, but also offers valuable references for high efficiency harvesting robot research.

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Streaming Media Systems

Application of Artificial Intelligence Technology in the Visual Communication Design of Shopping Platform

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Abstract. With the improvement of people's living standard, users of commodity experience requirements are getting more and more attention and shopping business to consumers to provide products at the same time also need the service should be paid more attention, so that consumers in the shopping process to obtain the best shopping experience. Computer vision is the study of how to make the machine to "see" science, further, is refers to with camera and computer to replace human eyes on target recognition, tracking and measuring, such as machine vision, and further to do image processing, computer processing becomes more suitable for the human eye observation or send it to the instrument to detect the image. As a scientific subject, theory and technology of computer vision research related, trying to build can be obtained from images or the multi-dimensional data information system of artificial intelligence. Here refers to the information refers to the Shannon definition, can help to make a "decision" information. Because perception can be thought of to get information from sensory signals, so the computer vision also can be regarded as a research how to make artificial systems from the images or multidimensional data "perception" of science. In this paper, the main purpose of the introduction of artificial intelligence technology in transmission shopping platform website visual design usability analysis, through the relevant theoretical knowledge and visual elements of the shopping website of usability evaluation and improvement, using questionnaire method to analyze the improved website and traditional website. To sum up some of the design methods and principles of shopping website interface.

Keywords: Artificial intelligence · Shopping site · Visual design · Digital technique

1 Introduction

With the development of artificial intelligence, the design of visual communication is more characteristic of the digital age than before. The development and application of artificial intelligence and multimedia technology in visual communication design have greatly changed people's idea and experience of traditional visual communication design.

Huang thinks that the influence of artificial intelligence technology in visual communication design reflected in the way of transmitting information and people's perception

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of visual language [1]. Pattern recognition is through the computer using mathematical method to study the model of automatic processing and interpretation. Here, we put the environment and object are collectively referred to as "model". Paper reference network. On computer implementation pattern (words, sounds, characters, objects, etc.) of the automatic identification, intelligent machine is the development of one of the key breakthrough, also provide clues for human beings to understand the intelligence itself. Computational identification of significant characteristic is high speed, accuracy and efficiency. The identification process is the same as the human learning process. "Voice recognition", for example: speech recognition is to ensure that a computer can understand what people said, an important example is the seven languages (English, Japanese, Italian, Korean, French, German, in spoken language translation system automatically. After the system implementation, people go abroad to book a hotel, buy ticket, dialogue and exchange foreign currency at the restaurant, as long as the use of the telephone network and the Internet, can be used with "*Laowai*" such as mobile phone, telephone calls.

Zhang believes that artificial intelligence technology to achieve the visual communication design of the characteristics of the multidimensional. Visual communication design through a comprehensive application of artificial intelligence technology and multimedia technology, visual communication and other fields of design Mastery [2]. *Gu* thought that under the influence of artificial intelligence, visual communication design mainly formed and developed based on modern computer technology and multimedia technology. Which is the social form of dissemination of great innovation and progress and the development trend in the future [3]. *Zhang* visualized that the design works of artificial intelligence based on the rich, multi-dimensional and universal, so that the design works of the user base more expanded, and affect the aesthetic trend of society. The purpose of visual communication design is to enable the audience understands the information and to facilitate the use of [4]. *Zhang* pointed out that the design of artificial intelligence in the field of visual communication has the characteristics of integration, interaction; humanization and information content [5].

In this paper, the main purpose of the introduction of artificial intelligence technology in transmission shopping platform website visual design usability analysis, through the relevant theoretical knowledge and visual elements of the shopping website of usability evaluation and improvement, To sum up some of the design methods and principles of shopping website interface is the application field, such as manufacturing, inspection, document analysis, medical diagnosis, and military and other fields of various kinds of intelligent/autonomous system an integral part of. Because of its importance, some advanced countries, such as the United States of computer vision in the field of computer vision and other relations.

Research as the economy and science has a widespread impact on the major basic issues of science and engineering, known as the major challenge (grand challenge). The challenge of computer vision is to have a computer and robot development and the level of human visual ability. Machine vision to the image signal, texture and color modeling, geometry processing and reasoning, and the object modeling. A competent visual system should handle all of these are closely integrated together. As a discipline, computer vision started in the early 1960's, but in many important advances in the study of the

basic computer vision is achieved in the 1980's. Computer vision is closely related to human visual, to human vision will have a correct understanding of the research in computer vision is very good. For this, we will first introduce the human vision.

2 State of the Art

2.1 Artificial Intelligence

Artificial intelligence is a new technology research, development, extension and expansion of human theory, method, and technology and application system of a new technology, referred to as AI. It is computer science, cybernetics, information theory, neurophysiology, psychology, linguistics, etc. A variety of disciplines mutual infiltration and developed a comprehensive discipline. From the point of view of computer application system, artificial intelligence is the study of how to make intelligent machine or intelligent system to simulate human intelligence activities, in order to extend people's intelligence science. Now used primarily in intelligent control, expert systems, robotics, language and image understanding, genetic programming robot factory [6].

2.2 The Application of Artificial Intelligence in Visual Design

In order to improve the development speed of the visual design system, to facilitate the process of learning, training, evolution, artificial intelligence is introduced into the design of computer vision is proposed, designed and built defect detection in a visual simulation platform, and target tracking and visual simulation platform [7]. In the simulation platform, we can carry on the research and development of target recognition, classified training and defect knowledge acquisition. It is safe, economical, repeatable and not restricted by site conditions. As shown in Fig. 1 for a typical visual creative design [8]. AI (Artificial Intelligence), abbreviations for AI. It is research, development, used for simulation, extend and expand the person the theory, method, technology and application of intelligent system is a new technology of science. Artificial intelligence is a branch of computer science, it attempts to understand the essence of intelligence, and can produce a new kind of response in the form of human intelligence similar intelligent machines, research in this field includes robot, speech recognition, image recognition, natural language processing and expert system, etc. [9]. The word "artificial intelligence" was originally brought forward according to the Dartmouth institute in 1956. Since then, researchers have developed many theories and principles, the concept of artificial intelligence has been extended. Artificial intelligence is a challenging science, engaged in the work of man must understand the computer knowledge, psychology and philosophy. Artificial intelligence is the science of including is very extensive, it is composed of different fields, such as machine learning, computer vision, etc. In general, one of the main goals of the artificial intelligence research is to make the machine to be able to do some usually require human intelligence to complete complex work. But different times, different people's understanding of the "complex" is different. Such as heavy science and engineering calculation to the brain for originally, now computer can not only complete the calculation, but also can do faster and more accurate

than the human brain, which in the modern age, people no longer see this as a "human intelligence is needed to complete complex tasks", visible is the definition of a complex work with development and technology progress of The Times change, the science of artificial intelligence with.

Fig. 1. Visual creative design

Under the background of the online shopping and the changing of consumption demand, in the eye with the chaos on the network platform. How to ensure that your own shopping platform to get more attention and click? The use of artificial intelligence, computer and other modern technology of shopping platform design, can not only meet the design requirements for the site, can also keep up with the pace of other new media, such as phone of new media, new television news media. For example, the clarity of the shopping process and guide page can give customers a free feeling, different from ordinary page, but to customers create a pleasant shopping atmosphere and interactive experience, to make shopping platform inject new vitality and energy. In this way can be directly on the shopping platform to reflect the image of the enterprise, in order to enhance the cultural value of the enterprise [10].

3 Methodology

3.1 Website Design Process

The design flow of the shopping platform of artificial intelligence technology mainly divided into three parts: information architecture, user experience, user interface, as shown in Fig. 2 [11].

Shopping platform website design through the structure, interaction, visual, information design four levels to analyze.

Structure design is shopping platform in the design of the skeleton, the customers and the enterprises demand as the basis, to the existing artificial intelligence computer technology for the relevant framework design, convenient for the user experience and business information communicated effectively. A shopping platform website built with

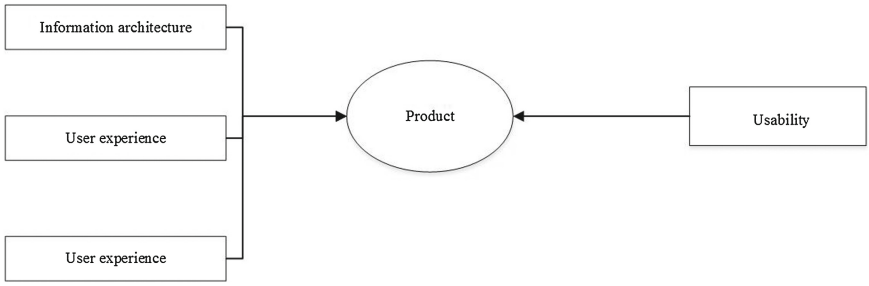

Fig. 2. The design flow chart of user centered

the environment of the market operation, with the obvious characteristics of the industry and the system of scientific and technological achievements [12].

Interactive design allows the target user is thinking mode, so that the operation is more in line with the habits of the target user. By using artificial intelligence, the use of feedback from users in the analysis of the online shopping website of questioning and impulse shopping and some of the problems, through the information feedback to the developers, developers should be attention to the target user with the traditional function of shopping and analysis, thus more effective application in the virtual electronic shopping.

Visual design based on the perceptual structure of the visual elements of the target user. For example, the size of the text, the brightness of the color, the authenticity of the image, the authenticity of the operating system, the sensitivity of the transmission of the target user information. Shopping platform has its own characteristics, in the visual attention to the color is too bright, the text is easy to identify, the layout is cumbersome, the real sense of the real sense of the goods, etc. The use of artificial intelligence technology can take care of each age layer of the user's visual experience; users can also according to their own preference Stewed the interface (see Fig. 3).

Fig. 3. The application of the reality

Information design is the degree of information users in the information to analyze and apply the information to improve the efficiency of the user to read the information.

Shopping platform will be an indication of some significant benefits such as looking for a product, transaction process, returned goods, payment instructions. When a developer is according to the importance of information using artificial intelligence technology to facilitate the presentation and access to read. As far as possible in the user experience, to convey the effective information to the user. In the use of color and graphics, it noted that the attention should be consistent with the site, but also focus on the needs of users to highlight the need to find.

4 Results, Analysis and Discussion

According to the time of shopping platform interface, the visual effect of artificial intelligence, optimization and invited 50 students through the experience of the new version of the web shopping platform and the traditional shopping platform, and to quantify the scoring. Results are shown in Tables 1 and 2.

Table 1. Scoring before and after improvement

Evaluating indicator	Excellent visual presentation	Excellent use interface	Good emotional appeal	Average score
The average score of the project (after optimization)	9.25	9.01	8.92	9.06
The average score of the project (before optimization)	8.65	8.92	8.43	8.67

Table 2. The average value of the operation mode of the improved website and the traditional shopping website

Operation mode	Ease of use	Operational coherence	Operation degree of freedom	Interface easy to read
The average score of the project (after optimization)	8	7.8	9	7.8
The average score of the project (before optimization)	8	7.6	5.8	7

From Table 1 shows, through the statistics of 50 sets of data, it said that, 50 investigators who experience no matter in the visual design of the interface or interactive experience. Based on artificial intelligence optimized shopping platform site scores are higher than those of the traditional shopping website are, feelings are more satisfied

with. The result indicates that the artificial intelligence is introduced for online shopping website user has a greater attraction and development space, can attract more customers and flow, generate more revenue, the technology of artificial intelligence and computer model is the introduction of the shopping website platform is an important development trend of the future.

From Table 2 shows, in the contrast through the artificial intelligence technology to optimize visual design, shopping platform sites with contrasting traditional shopping website operation mode, whether it is in the operation of coherence and easy identification of superior, in degrees of freedom also has good operating experience. International air the frontier and interdisciplinary research as a science, but like many emerging disciplines, artificial intelligence has no unified definition. To give next accurate definition of artificial intelligence is difficult. Many human activities, such as computation, guessing riddles, discussion, planning and writing computer programs, or even driving and riding a bicycle, and so on need to be "smart". If the machine can perform this task, you can think machine has some properties of "artificial intelligence" Therefore, in the design and development of the electronic shopping mall, select the design based on artificial intelligence optimization is the most fitting user interaction habits.

5 Conclusions

This paper is based on the network-shopping platform of artificial intelligence technology in visual communication design application as the research object. Through the development of artificial intelligence technology, and application of the investigation and analysis. From a graphic design point of view, with the visual language of graphic design to explore the clothing in the network platform by showing the different forms and interactive shopping experience. Due to limited scope of this paper, the study population is small which needs to follow further studies.

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Research on Image Fingerprint Technology Based on Watson Visual Model Multimedia Technology

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Abstract. Computer network has greatly changed the life and work of people, the demand of people for information has been developed from the single text message to the current graphics, images, audio, video and other digital multimedia forms. With the development of a large number of multimedia applications, the digital image is easy to be operated and tampered, this paper aims to study an image fingerprint algorithm based on the masking characteristics of the human eye. An image sensing Hash algorithm based on human visual model is proposed to effectively eliminate the influence of geometric attacks. Watson visual model is used to deal with the DCT coefficients to produce the image fingerprint sequences, which has excellent robustness and security. The experiment proves that the algorithm can certify the copyright of the image, reduce geometric attacks, JPEG compression and other attacks, it can also use the key to generate the pseudo-random matrix, so as to encrypt the image, and effectively realize the security of the algorithm.

Keywords: Watson visual model · Image fingerprint algorithm · Regularizationc

1 Introduction

Computer networking has greatly changed the life and the work of the people where the human beings have entered a new era of information from the industrial age. The demand of people for information has been traced from the single text message to the current graphics, images, audio, video and other digital multimedia forms, which has provided a great convenience for people's daily life and work in the form of the multimedia. Among them, compared with the text and audio, video and other forms of multimedia, digital image has the characteristics of simple and easy to understand, the ability of the transmit information of which is stronger and more intuitive, so it is the most widely used multimedia forms in people's daily life and work, and becomes an important way for people to obtain information and share information. On the other hand, such as photoshop, Mito Xiu Xiu and other digital image processing software are developed, which help the people to modify and fabricate digital images. At the same

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time, it is easy for people to carry out any copy, spread, and even deliberately illegal tampering the multimedia, which leads to the problem of digital image security. Compared with other forms of multimedia, digital image has obvious advantages, such as the features of holding large amount of data, high redundancy, modification and so on, and these make the digital image as the primary object of the malicious reward change and dissemination. With the rapid development of computer network and multimedia technology, it is easy for people to tamper with the digital image and spread, so the integrity of the content of the image, the authenticity of the information conveyed and other security issues have become the urgent problems to be solved. The application of a digital image is very extensive, if the content of tampering involves the political, military, medical, forensic evidence and other important confidential information in sensitive areas. It will bring a great impact on people's lives, and may even lead to medical accidents, so that the patient's life and health are threatened. Thus, a technique for ensuring the authenticity of image data – image authentication technology arises at the historic moment. One of the basic ways of the image authentication technology is the image authentication based on digital signature, where the digital signature is similar to the handwritten signature in real life, and it is used to identify the digital information. The earliest digital image signature technology uses public key cryptography to generate a string that can't be forged by other people except for information sender. In recent years, the technology of image authentication based on Hash has become a hot research topic in the field of image authentication technology. Perceptual Hashing technology originated from the traditional cryptography and digital watermarking and other technologies, which has provided a technical support for the content identification and authentication of multimedia information, and has become a hot research topic in recent years. The research focus is the image perceptual hashing which will extract the invariant features of the image, and map it to a brief summary of the digital image, then use the distance measure and matching algorithm of Hash to complete the matching of the abstract, so as to realize the recognition and authentication of the image content. Image perceptual Hash technology extracts image perceptual content and information, and carries out the compression, coding, so as to form a brief summary of the digital image, then the authentication of digital images is realized through the matching of the abstract. Image authentication is essentially concerned with the perceptual information conveyed by the image rather than the carrier itself, most of the features of the existing Hash algorithms have not yet risen to the perceptual level of the human visual system. The experimental results show that some of the characteristics of the human visual system are added to the perceptual distance measurement, which is more in line with the human perception of the image, but the robustness of these algorithms to geometric attacks is not high [1]. Research on image authentication technology based on Hash is helpful to solve the problems of image authentication technology in the practical application environment. The technology of image authentication based on Hash perception has become a very important research direction in the field of multimedia information, therefore, the research on perceptual Hashing is not only an important academic subject, but also a more challenging and widely applied prospect. In this paper, a perceptual Hash algorithm based

on regularization and Watson visual model is proposed. This scheme solves the problems that the existing algorithms are not robust to geometric attacks by using the regularization method, and the measurement result of the perceptual hash distance of the visual system is more consistent with the subjective perception of the image. In the process of image sensing Hash generation, the key control is added to improve the security of Hash.

2 Background

Image fingerprint authentication technology is developed from the traditional password related knowledge, which is a kind of authentication technology that uses the images to perceive the content [2]. It mainly uses the extraction of multimedia content and the perception of information to describe a simple digital overview of multimedia content, then provides support for the identification, authentication, and modification of the content of the multimedia information by matching the operations of the digital summary. With the upsurge of research, many domestic and foreign researchers have proposed a number of image fingerprint algorithms to carry out the identification and calculation of multimedia information. Niu puts forward that the recognition of the digital digest is the basis of image fingerprint [3]. In the literature [4], the cosine transform discrete (DCT) is carried out by using the images of different block regions; this method can be used to identify whether the image has been tampered and compressed, but this method can't have a good robustness. Liu uses image fingerprint technology and digital watermarking technology to propose a new algorithm which is suitable for the discovery of the modified region [5]. The proposed algorithm can be used to get a good recognition accuracy in the identification of illegal modification and low pass filtering, but this method also can't have a good robustness. Prungsincha uses the Fourier-Mellin transform to extract the invariant features as a basis for the fingerprint image authentication [6]. This method of algorithm has the problem of poor robustness to rotation operation. Tang uses a non-negative matrix factorization algorithm (NMF) and the discrete cosine transform and the non-negative matrix factorization to authenticate the fingerprint image [7] which proved to provide effectiveness in resisting the content and keep the operation, but there is no good robustness when the rotation attack occurs. Qinchuan uses the Watson model to develop a new algorithm, the algorithm can effectively reduce the loss of the JPEG compression and Gaussian filter, but the robustness of the algorithm is poor under the conditions of rotating geometric operations [8]. Zhang Hui studied the masking properties of human vision, and then merges it into the image fingerprint algorithm [9], but this algorithm has no good effect on geometric attacks such as rotation and shearing. In the process of improving the SSIM visual model, Hu Yuanyuan realizes the feature recognition of the original image and transform domain, and realizes the localization of tampering [10]. Hu proposes an image fingerprint algorithm which can adjust the visual threshold, the algorithm has a good distinction [11]. Ghouti uses the singular value decomposition to generate a low order of the four element matrix in the color image feature extraction, this algorithm can avoid the error classification and have a good safety performance [12].

3 Methodology

Image fingerprint authentication technology is developed from the traditional password related knowledge, which is a kind of authentication technology that uses the images to perceive the content [2]. It mainly uses the extraction of multimedia content and the perception of information to describe a simple digital overview of multimedia content, then provides support for the identification, authentication, and modification of the content of the multimedia information by matching the operations of the digital summary. With the upsurge of research, many domestic and foreign researchers have proposed a number of image fingerprint algorithms to carry out the identification and calculation of multimedia information. Niu puts forward that the recognition of the digital digest is the basis of image fingerprint [3]. In the literature [4], the cosine transform discrete (DCT) is carried out by using the images of different block regions. This method can be used to identify whether the image has been tampered and compressed, but this method can't have a good robustness. Liu uses image fingerprint technology and digital watermarking technology to propose a new algorithm which is suitable for the discovery of the modified region [5] and this algorithm can be used to get a good recognition accuracy in the identification of illegal modification and low pass filtering, but this method also can't have a good robustness. Prungsincha uses the Fourier-Mellin transform to extract the invariant features as a basis for the fingerprint image authentication [6], which has the problem of poor robustness to rotation operation. Tang uses a non-negative matrix factorization algorithm (NMF) and the discrete cosine transform and the non-negative matrix factorization to authenticate the fingerprint image [7]. This algorithm can effectively resist the content and keep the operation, but there is no good robustness when the rotation attack occurs. Qinchuan used the Watson model to develop a new algorithm, where the algorithm can effectively reduces the loss of the JPEG compression and Gaussian filter; but the robustness of the algorithm is poor under the conditions of rotating geometric operations [8]. Zhang Hui studied the masking properties of human vision, and then merges it into the image fingerprint algorithm [9]; but this algorithm has no good effect on geometric attacks such as rotation and shearing. In the process of improving the SSIM visual model, Hu Yuanyuan realized the feature recognition of the original image and transform domain, and found the localization of tampering [10]. Hu proposed an image fingerprint algorithm which can adjust the visual threshold; the algorithm has a good distinction [11]. Ghouti used the singular value decomposition to generate a low order of the four element matrix in the color image feature extraction where this one can avoid the error classification and have a good safety performance [12].

3.1 Image Fingerprint Algorithm

The general image fingerprint feature generation framework includes 3 parts: fingerprint extraction, quantification and coding. In this paper, the basic framework of image fingerprint generation is shown in Fig. 1. After the regularization processing of the image, the feature extraction is carried out to meet the requirements of the robustness of image fingerprint, and the DCT coefficients of the Watson visual model are processed

Fig. 1. Image fingerprint identification technology

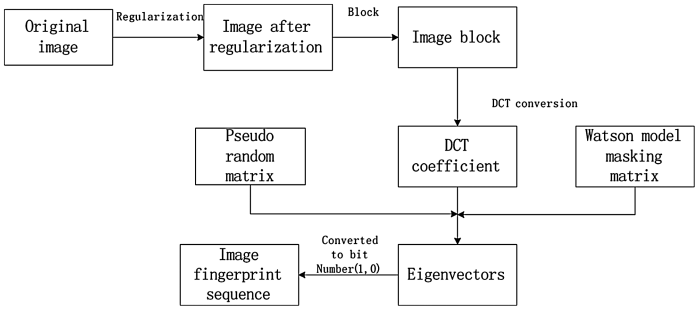

Fig. 2. Fingerprint image generation

to meet the visual characteristics of human, then the false random matrix is joined to ensure the safety of feature vectors (Fig. 2).

The visual model based on the DCT proposed by Watson is a classic perception model which combines the contrast sensitivity, the masking effect and the error combination. It can well generalize the visual characteristics of the human eye where the perceptual distance measurement of the image is in line with the subjective measurement of the distance to the human [13]. The Watson model mainly consists of 4 parts: the contrast sensitive table, the luminance masking, the contrast masking and the perceptual quality measurement. The minimum DCT coefficients that can be perceived in the absence of masking are compared to each of the digits in the sensitive table, the smaller the value is, the more sensitive the human eye is to the frequency. The value of the luminance masking threshold is influenced by the contrast masking, and there is a contrast masking threshold. For each DCT block, there are:

$$t_{C_{i,j}} = \max\left\{t_{L_{i,j}}, \left|DTCcoef_{i,j}\right|^{w_{i,j}} \times t_{L_{i,j}}^{1-w_{i,j}} {}_{j}\right\} \tag{1}$$

Among them, $t_{L_{i,j}}$ represents the luminance masking threshold, $w_{i,j}$ is a constant, because the frequency coefficient is different, which determines the degree of contrast masking. Under normal circumstances, $w_{0.0}$ takes 0, the other $w_{i,j}$ take 0.7. $DTCcoef_{i,j}$ is the DCT coefficient of the image block. The final contrast masking threshold is the biggest one in the luminance threshold value.

3.2 Fingerprint Extraction

In this paper, firstly, the image is processed by regularization, and the image can be obtained by a geometric transformation. Setting $f(x, y)$ is the digital image with the size of $M \times N$, its moments and center distance are defined as m_{pq} and μ_{pq}, $p, q \in Z^+$, then:

$$m_{pq} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} x^p y^q f(x, y) \tag{2}$$

$$\mu_{pq} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} \left(x - \bar{x}\right)\left(y - \bar{y}\right)^q f(x, y) \tag{3}$$

Here, $\bar{x} = \frac{m_{10}}{m_{00}}$, $\bar{y} = \frac{m_{01}}{m_{00}}$

The specific process of image regularization is as follows:

Step 1: Center of the original image $f(x, y)$ is obtained: $f_1(x, y) = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} x \\ y \end{pmatrix} - \begin{pmatrix} d_1 \\ d_2 \end{pmatrix}$, $d_1 = \frac{m_{10}}{m_{00}}$, $d_2 = \frac{m_{01}}{m_{00}}$, this step eliminates the translation of refinery transformations.

Step 2: The direction x of the shear transformation $f_1(x, y)$ can be obtained: $f_2(x, y) = \begin{pmatrix} 1 & \beta \\ 0 & 1 \end{pmatrix} \cdot f_1(x, y)$.

Step 3: The direction y of the shear transformation $f_2(x, y)$ can be obtained: $f_3(x, y) = \begin{pmatrix} 1 & 0 \\ \gamma & 1 \end{pmatrix} \cdot f_2(x, y)$. The step 2 and the step 3 eliminate the shear of the x and y directions in the refinery transformation.

Step 4: Scale transformations in the x and $y$directions can be obtained: $f_4(x, y) = \begin{pmatrix} \alpha & 0 \\ 0 & \delta \end{pmatrix} \cdot f_3(x, y)$, this step eliminates the scaling of refinery attacks.

Fingerprint extraction is the key of image sequence generation, and the Watson model is used to deal with the image block DCT coefficients, and the specific steps are as follows:

Step 1: After the regularization, the image size is 512 × 512, the image is divided into 8 × 8 blocks, and then the DCT transform of the image block is carried out, and the DCT coefficient matrix $DctCT_n$ of each block can be obtained;

Step 2: The contrast masking matrix $DctI_n$ of each image block is calculated, and the reciprocal matrix $DctI'_n$ of each element is obtained;

Step 3: According to the corresponding position in the image, the DCT coefficient matrix $DctCT_n$ is combined to get the coefficient matrix $DctCT$ of the size of 512 × 512, which is similar to the $DctI'_n$, and the masking matrix $DctI$ of 512 × 512 is obtained;

Step 4: According to the key k, n 512 × 512 pseudo random matrix is produced, the elements of the matrix are independent of each other and obey the standard normal distribution, which are denoted as A, then:

$$Y_n = \sum_{i=1}^{512}\sum_{j=1}^{512}[DctI \cdot DctCT \cdot P(i,j)], \text{ in which}, 1 \le n \le N, 1 \le i \le 512,$$
$$1 \le j \le 512;$$

Step 5: Each bit is generated from the bottom of the image according to the generation of the final image fingerprint:

$$h_n = \begin{cases} 0, & if\ Y_n < 0 \\ 1, & if\ Y_n \ge 0 \end{cases} \quad n = 1, 2, \cdots N \tag{4}$$

4 Results, Analysis and Discussion

In order to investigate the performance of this algorithm, the uniqueness, robustness and security of the three experiments are carried out in this work. In robustness experiment, the algorithm of proposed in this paper is compared with the algorithms in other literature where the methods of fingerprint sequence and distance measurement are different. In this paper, the perceptual distance normalization method is used to compare the perceived distance d_{diff} between the two different images, and the desired distance is used as the sensing distance, then the perceptual distance d_{same} of two identical images is calculated, the interval $[d_{same}, d_{diff}]$ obtained by different algorithm is normalized to the same interval [0,0.05] and the test results of the different algorithms can be compared under the uniform standard.

4.1 Uniqueness Experiment

The uniqueness of the image fingerprint depends on the human perception threshold. If the difference between the two images is less than or equal to the threshold value of human perception, the contents of the two images can be regarded as the same, if the difference is greater than the threshold value of human perception, the contents of these

two images are different. In this experiment, 100 images of the USC-SIPI standard image database are selected, and the 4950 groups of perceptual distance are obtained by the matching of two-two groups from the 100 groups. The experimental results fit the standard normal distribution, in which, the mathematical expectation is $\mu = 0.3994$, the standard deviation is, $\sigma = 0.0426$ and the threshold is $T = 0.15$, As a result, the image conflict rate is:

$$p = 1 - \int_{T}^{\infty} \frac{1}{\sqrt{2\pi}\sigma} e^{\frac{-(x-\mu)^2}{2\sigma^2}} dx = 3.3794e - 0.07 \tag{5}$$

Because the collision rate is 10-7 orders of magnitude, so this method can ensure the uniqueness of the image.

4.2 Robustness Test

In the USC-SIPI standard image library, an initial image is selected, and the Stir-Mark software is used to attack the image, including rotation, scaling, shearing, median filtering, JPEG compression, fuzzy, Gauss noise and other attacks. In this study, the experimental results of Lena, Airplane two images are shown in Table 1.

Table 1. Perceptual differences of various perceptual content invariant operations

Attack type	Lena	Airplane	Attack type	Lena	Airplane
JPEG, QF = 30	0.020	0.017	Twist	0.033	0.035
Rotate 2°	0.053	0.051	Brightness decrease	0.004	0.005
Rotate 15°	0.148	0.151	Brightness enhancement	0.006	0.045
Enlarge 50%	0.045	0.050	Median filtering	0.037	0.040
Narrow 10%	0.085	0.077	Gaussian noise	0.146	0.153
Shear 20%	0.134	0.138	Vague	0.122	0.127
Shear 23%	0.149	0.147	Mosaic	0.089	0.078

From Table 1, it can be seen that the algorithm proposed in this paper has a more robust feature for most of the perceptual operations, and can effectively resist JPEG compression, the shear, median filtering, noise, the rotation and scaling attacks.

At the same time, the algorithm proposed in this paper can calculate the fingerprint characteristics of the original image compared with other algorithms. After the JPEG compression, shearing, median filtering, rotation processing, the fingerprint features are calculated, so as to compare with the fingerprint features of the original image, the experimental results show that this algorithm is more robust where all the values are below 0.052 and hence the algorithm is very robust to JPEG compression. From the performance of median filter, it can be seen that the performance of the algorithm is excellent.

4.3 Safety Test

In this paper, the key way is used to generate a pseudo-random matrix, which is for the security of fingerprint features to consider. Based on different key, different pseudo random matrix will be generated, which makes the final image fingerprint different. Different keys are selected to match the test with 1000 images, and the matching results are formed, Then the same key is used to carry out the matching test for the 100 images, so as to generate 4950 matching results.

5 Conclusion

Perceptual Hash has the characteristics of robustness, uniqueness, security, abstract and one-way. Scholars at home and abroad have tried to improve the security of the extracted image features by constructing efficient perceptual Hash algorithm. In this paper, an image sensing Hash algorithm based on human visual model is proposed, then, the DCT coefficients are processed by the WATSON visual model to generate the image perceptual hash sequences with strong robustness and security. The experimental results show that the proposed algorithm can improve the robustness of image sensing Hash, and can effectively resist the attacks of rotation, scaling, refinery transformation, JPEG compression, 24% of shear and so on. At the same time, according to the key, the pseudo-random matrix is generated, and the eigenvalue is encrypted, which ensures the security of the algorithm. In addition, the uniqueness of Hash sequence is proved by experiments. The algorithm proposed in this paper can be applied to the copyright authentication and recognition of digital images.

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Elements of Music Based on Artificial Intelligence

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Abstract. In recent years, computer technology and multimedia technology have been developing rapidly; and information technology, the representative, has been widely penetrated into many courses. Thus, for the current status of research and practical music audio processing needs and the particularity of music causes some problems with the application of computing technology in music creation at present, such as some forefront music theories and technology can not be well applied in music practice., this paper argues, the music element analysis technology is the key to this research field, and on this basis, proposes a new framework music processing - Music calculation system, the core objective is to study intelligently and automatically identifies various elements of music information and analyze the information used in constructing the music content, and intelligent retrieval method translated. To achieve the above core research objectives, the paper advocates will be closely integrated music theory and calculation methods, the promotion of integrated use of music theory, cognitive psychology, music, cognitive science, neuroscience, artificial intelligence, signal processing theory to solve the music signal analysis identify the problem.

Keywords: Music elements · Music calculation · Music automatically escaped · Debugging detection · Chord recognition

1 Introduction

Music is one of the oldest art forms and the most universal appeal, is the human voice through the kind of harmonious and orderly permutations and combinations to express thoughts and feelings, to communicate with each other special language. Music creation, performance, understanding, appreciation, is one of the most basic human mental activity. As the most important carrier of human culture, music has a rich culture and history connotation characteristics, so the heritage of thousands of years, still occupies an essential place in human life. In the new era, its meaning, and the existing forms of communication, along with the rapid development of high-tech, it has been made a new interpretation [1]. This research conforms to the current development of music education in China, aiming to study the effective methods in music teaching of the computer technology and the unfavorable factors. And the teaching ideas and methods use the most advanced computer music software as well, Not only improve and develop traditional music teaching, but also renew teaching ideas and make a little contribution to the reform and the development of music education.

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Artificial Intelligence is a new technology to study and develop the theory, method, technology and application system for simulation, extension and expansion of human intelligence [2]. Artificial intelligence is a branch of computer science. In order to understand the intelligence essence and produce an intelligent machines which react like human being. The research in this field has become increasingly mature. The application of this technology is also expanding. Nowadays, artificial intelligence has been applied in the music area.

Before the advent of computer music technology, music production probably has to go through a number of events: the first is the creation of the composer. According to his own experience and writing requirements of the composer to complete the creation of the works, that is to write a variety of musical instruments [3]. Then to please the relevant bands, such as acoustic band, orchestra or band of people to orchestration, rehearsal and recording.

The content-based music information retrieval and calculation is based on the theory of intelligent music technology comparison, we found that, although both the purpose and application of different directions, but in its core research issues and current research bottlenecks encountered but it is the same - how to intelligently analyze and get the music based on the audio content shown by the various elements of music and other useful information. Music elements generally refer to part of the logical structure of the music theory within the framework of the music: if the music analogy is a language system, elements of music is music language "words, words, sentences and chapters". Specifically, from the music theory, by definition, elements of music summarized the various elements of music and music support the interpretation of the various means of expression, which can be divided into two basic elements and form elements level [4]. Mainly refers to constitute the basic elements of music, showing the basic elements of the physical properties of sound: pitch, intensity, duration and timbre of the notes; and music by the above basic elements combined with each other and the role of support to form a musical interpretation, music theory form elements system systematically discussed: melody, harmony, melody and rhythm, speed, strength and so on; and in the broader level, the music basic elements and form elements of the combination can also be defined as style, emotion, structure belt there are cultural and subjective description tag music overall macro-elements [5].

Specific to real-world applications, effective analysis of the elements of music for music information retrieval and intelligent music teaching and creation of great significance [6]. For music information retrieval, build all kinds of indexing as much as possible from different angles is a key precondition for the effective mass music information retrieval; at the same time, from different angles on music similarity measure is the core issue of sample retrieval. Among them, tuning, style, global music elements can be retrieved according to different user requirements to provide index and enrich the massive database management; global elemental structure, melody and so that you can measure the similarity between the music section is provided on the structural characteristics of music basis, but also provide an important feature for achieving humming [7]. For music teaching and the creation of the field of intelligence, musical notes, chords, melody and other musical elements of melody recognition is a necessary part of the whole score is automatically translated [8]. The music is automatically translated, music can be directly converted into music characteristics that can

be applied to music teaching visual, musical ear training and many other areas, to improve music teaching autonomy, efficiency and intelligence have a huge role in promoting [9]. At the same time, music is a way to improve music rendering efficiency and the level of intelligence important assistive technology, which can greatly simplify the process of music - composers by playing or singing to music and to complete the modification process, change the current side playing side edge modified traditional notation creation mode, making the popularity of music possible [10].

2 Materials and Methods

2.1 Music Calculate the Theoretical Basis for System

From a long historical period, the music as one of the main carriers of human culture and the spread of emotional interaction, carrying a very rich connotations. These connotations from the perspective of human music display and processing mechanisms to understand, can be broadly divided into two categories, namely physical and psychological connotation [11]. And according to these two types of music connotation decomposition, we can be decomposed into music sound component attributes and mental attributes component level two connotations (See Fig. 1).

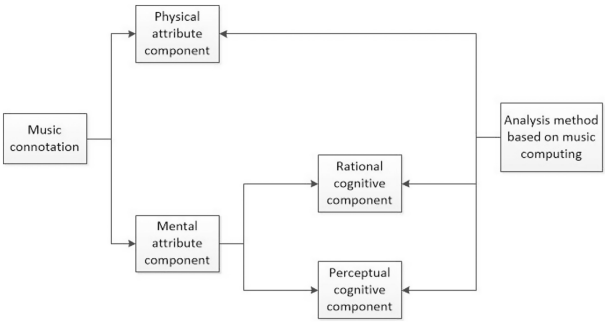

Fig. 1. The theoretical basis of music computing

In the creation, performance, production and dissemination of the use of computer technology or equipment music, that is, in the entire human music activities in the computer to participate in music [12]. It is the inevitable result of the combination of music art and modern electronic science and technology. From the history of musical development, the development of electronic music to a new stage after the emergence of computer music [13].

Such as MIDI, which is a language for information exchange between automated instruments [14]. The MIDI file is not a recorded voice, but in the process of recording music sound information, including the treble, rhythm, timbre, intensity, pitch, notes, beginning notes to play the instrument, the volume of notes and time instruction. Compared with the music waveform file, the main advantage: Firstly, the information is

easy to modify, change the pitch of a voice, it only needs a mouse click to complete. Print and track configuration or staff notation is also quite easy [15]. Secondly the production of a smaller amount of data, ease of storage and network transmission. The deficiency is that MIDI music is difficult to reproduce the true nature of the sound of a musical instrument [16]. In addition to the application of music, the stage sounds, lighting and other digital devices are widely used as well. Here are some pictures about scenes related to music.

Fig. 2. Scenes related to music

2.2 Music Method of Computing Technology

Study the music is calculated and the music audio content contained in the various elements of music. From the perspective of content analysis point of view, every kind of music has elements of the above-mentioned three-level attributes. From the position for the characteristics of the music content and the use of these features in music theory system point of view, but also the characteristics of these elements into three categories: low-level features, intermediate, advanced features and characteristics [17]. Low-level feature itself is not music elements, it is the use of statistical pattern recognition methods extracted from the music audio statistical features, such as MFCC, spectral flow, etc., this feature in the traditional speech/audio processing method in wide range of applications. Intermediate features music belongs to the basic elements and form elements, such as scales, chords, rhythm, with its music analysis method is the basic method of music theory model [18].

Computing technology software generally has the function of audio-visual integration, which fully embodies the characteristics of sound, makes up the history of

written or printed paper music without sound. Computing technology software is fast and convenient, and can play all kinds of music scores over and over again. In the course of repeated practice, people can master the basic theoretical knowledge of music [19]. Their basic quality of music, music professional skills have been improved.

$$f(t) = \int_{-\infty}^{+\infty} e^{itx} dF(x), \quad t \in R \tag{1}$$

$$f(t) = E\left(e^{it\xi}\right). \tag{2}$$

$$f(t) = \sum_{k} e^{itx_k} p_k, \quad p_k = P\{\xi = x_k\}. \tag{3}$$

The advanced features music is based on the overall structure or global properties, such as the musical structure, style, emotion and other macro-elements, which are the main object of study in cognitive psychology of music. It is worth mentioning that the musical tune style and melody of these two music global properties, according to our classification should belong to the advanced features, but because of its relationship with the music basic elements is extremely close, is the core concept musical tone theory system and the main elements of the form, and is often used in conjunction with some of the basic elements of music, so here it is classified as intermediate feature classes [20].

2.3 Music Computing Research Tasks

Each proposed theory must be supported by a variety of practical research under its framework may verify their theoretical value. Layer theory and technical level in the previous section of this article has been calculated from the music to the music computing system conducted in-depth exposition, so this section will describe specific research tasks under the framework of music theory constructed in this paper, that is music computing tasks layers. Objects Music Computing research is real world music audio exhibited musical elements, each study task is outside to the inside - the establishment of the sense of hearing music audio characteristics (sound property) intelligence methods to reflect internal principles and laws. Therefore, the study of music computing system task in this paper are elements external sound for music performance. Most of the studies have been presented by the task before the introduction of MRI technique, this paper will reorganize and to describe the connection between the various tasks. As each task is a study for one or a few attributes of music analysis, this section is still in use on the section of the proposed property classification, the different levels of research tasks in accordance with the study of music and their mutual property relations classification (See Fig. 3).

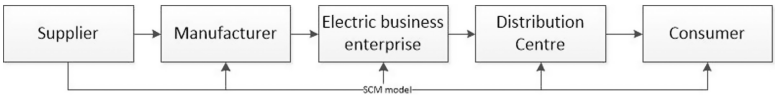

Fig. 3. The progress of computing

3 Results

Music Information Retrieval and music teaching intelligent and creative problem its urgent application requirements and broad market prospects, becoming the music information processing two research focus, but also audio signal processing technology and humanity's oldest carrier in Arts & Culture effective combination of theory and practice. On this research, the music element analysis technology is the music information retrieval and intelligent music teaching and research co-creation of the core issues and research focus. Elements of the core issues in the music of the musical signal processing, the proposed calculation music system. Traditional music and signal processing technology, here are calculated within the framework of music, from music theory, guiding cognitive theory, the establishment of new methods of intelligence analysis to identify elements of music. Based music computing system, the paper some music signal processing techniques are studied; and music computing technology system under the guidance for tuning and chord core musical tonality property elements, melody and other musical major evolution in the form of elements and musical structure and other styles Global information elements were studied. Significance of the study of the music that elements of analysis: the music information retrieval direction, factor analysis can help build category-based search index, based on a sample retrieval and sample similarity measure: tuning, style, global factors may be Music is retrieved according to different user requirements to provide index, rich massive database management; global elemental structure, melody is the main music piece based on the similarity between the metrics on the structural characteristics of the music, and the achievement of an important feature of humming retrieval. Identification and creation in music teaching intelligent direction, notes, chords, melody and rhythm and other musical elements are a core component of the full score is automatically translated. The music is automatically translated visual music teaching, music teaching autonomy and improve the efficiency of the core practical skills, but also to simplify the process of music creation and improve the efficiency of an important creative assistive technology.

The application of computing technology in music teaching is the necessary result of social development, and it will develop with the development of the times. The use of computer music software to music has brought a revolution, and have a tremendous impact on the music creation system from the theory, means, methods and so on.

4 Conclusion

Music calculation proposed framework, and form a hierarchical theory expounded theoretical basis method needs, as well as applied technology research tasks of this framework. Music Computing Architecture will feature various aspects of information processing in the field of music organized and orderly, and a targeted selection of music as a core element analysis research direction for music information retrieval and intelligent music teaching creative problem solving and provides a theoretical basis, defined the research objectives and the research provides a way of thinking effectively support.

According to the sound properties of music known to psychology and music theory, put forward the assumption that human perception of music type based on selective attention, whereby to obtain calculated acoustic auditory saliency features and applied music melody analysis on the portion. Meanwhile, according to the cultural attributes of music paper classical model of music theory proposed music theory auditory saliency features, and use the full auditory saliency features, combined with technology and music theory rules proposed in this paper, we propose a effective automated music translation methods. Experiments show that the auditory saliency features can be very accurately capture the music in a significant part of music theory rules can also be good for the recognition result "filtering"; and in general, the proposed musical automatic translation technology can achieve industry-leading technology similar performance, and can be subjective sense that hearing people can accept.

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Video Steganographic Algorithm Based on Intra Prediction Modification for H.264/AVC

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Abstract. To analyze the technique of video steganography, which provides security guarantees for national security and confidential information of government agencies and enterprises, videos may be used to transform secret information and then achieve the goal of covert communication. Aim to use the specific features of the H.264–intra prediction mode, and decrease the modification rate, we present a video steganography method based on logistic mapping and the intra prediction mode in H.264/AVC. First of all, we process, the secret information from logistic sequence. Then we use the parity of intra prediction mode of 4 × 4 blocks group. Further, embed secret information by modifying the parity. Experimental results indicate that our algorithm has good invisibility, little influence on the bit rate of the video carrier, and the modification rate is low.

Keywords: Video · Steganography · Logistic map · Intra prediction

1 Introduction

Nowadays, people get more convenience from the rapid development of Internet, we share, view, get the information from everywhere, then a big problem has come into being, the security of very important information. To ensure the security of it, people proposed information hiding.

Information hiding, also called steganography, is the method that hides the secret messages into ordinary carrier without revealing its existence [1]. The carrier (or called a cover file) may be a digital image, audio file, or video file. If the secret information has been hidden into the cover file, we can transfer it across the public channel, whether safe or not.

In the past years, the development of information hiding based on digital image has achieved great progress. Researchers have proposed many high-performance algorithms, such as LSB [2], LSB matching [3], F5 [4], nsF5 [5] and some recently-emerged adaptive ones, like HUGO, WOW, MVGG, UED [6–9]. However, its limited size also

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restricts the capacity we want to hide in. For this reason, information hiding based on digital video has come into being in recent years [10–14].

Compared with traditional media, like digital image, the capacity of video is large, which brings about greater convenience for information hiding, and the video also has a large capacity, more redundancy, high communication quality and robustness, etc.

H.264/AVC is the most mature standard for video compression with high compression efficiency and transmission reliability; furthermore, it is well adapted for network transmission. From the day it was put forward, H.264/AVC has replaced most standards, and many videos are compressed by H.264/AVC. Many video websites use H.264 as the first compressed standard [15]. Therefore, research on H.264/AVC data hiding methods is very valuable.

For analysis the usage of intra prediction mode in the information hiding algorithm, Ref. [16] through modifying intra prediction model according to the prediction modes, and the mapping rules between intra 4×4 block and the embedded bits, but the difference is big for different test sequence, and the mapping rules do not have general applicability. Based on reference, Refs. [17, 18] modify the prediction model of the 4×4 brightness block, combined with matrix coding, can embed two bits by modifying a prediction model. References [19, 20] also proposed 2 H.264/AVC video information hiding scheme based on intra prediction mode.

References [21–25] based on the new technique of HEVC, proposed a scheme of embedding the hidden information in the prediction model of the 4×4 luminance block in the modulation frame. Use the secret information itself as the key to selecting the embedding position, disrupting the embedding order. But the algorithm modification rate is high.

In this paper, we present a video steganography algorithm that is efficient, high security, and can be used in covert communication. The main contributions of the work are as follows. First, we pretreat the secret with logistic map, aim to improve the security of our method. Second, we use the intra prediction modes of texture features. Third, we modify the parity of the modes from a block group to hide the secrets.

The rest of this paper is organized as follows: Sect. 2 describes the preliminaries of our scheme. In Sect. 3, the embedding and extracting mechanisms are described in detail. We give the experimental results and analysis in Sect. 4. In Sect. 5, a conclusion and future work is finally drawn.

2 Preliminaries

2.1 Intra Prediction

Unlike previous coding standards, H.264/AVC introduces a new prediction model based on inter prediction, intra prediction. Intra prediction is a technology that exploiting spatial correlation to predicted coding, standards before using only the correlation inside macroblock, so in order to use the correlation between macroblocks, H.264 uses the coded macroblock to predict the pixel value of current macroblock, and then code the difference between the predicted one and current one. According to the

size of the macroblock, the prediction model has three kinds: intra_16 × 16, intra_8 × 8 and intra_4 × 4.

In the intra prediction process, firstly predicts the current block according to the encoded blocks and calculate out the difference between the current block and prediction block. Different encoding modes lead to different values of the difference in the calculation process. A good coding mode can minimize the difference.

In order to predict the frame details, intra prediction, mainly adopts the prediction 4 × 4 luma block frame. We assume there exist a block (the left block as well as the upper block has been encoded and reconstruct). Figure 1 shows the prediction 4 × 4 block and adjacent pixels numbered diagram, which capital letters A-L are already coded and reconstructing, and they can be used as predicted pixel, lowercase letters a-p are currently being coded block of pixels.

M	A	B	C	D	E	F	G	H
I	a	b	c	d				
J	e	f	g	h				
K	i	j	k	l				
L	m	n	o	p				

Fig. 1. Current block and the adjacent pixel diagram

In 4 × 4 block, lowercase letters a-p are predicted pixel points, and capital letters A-L are the encoded pixel. Such as the value of the/point can be predicted by $(J + 2K + L + 2)/4$, can also be predicted by the $(A + B + C + D + I + J + K + L)/8$, and so on. According to the different selected predictive reference point, the brightness of a total of 9 different classes of models, namely: mode 0: vertical prediction; model 1: horizontal prediction; model 2: DC prediction; mode 3: left lower diagonal prediction; mode 4: right lower diagonal prediction; mode 5: vertical partial right prediction; mode 6: horizontal partial deflection prediction; mode 7: vertical partial left prediction; mode 8: horizontal partial upper prediction. Figure 2 shows 9 different predictions.

2.2 Logistic Mapping

Logistic map is a typical nonlinear chaotic equation, which originates from a population statistic dynamical system, although it is simple, but it shows the basic characteristic of chaotic motion.

We can define this map as follows:

$$x_{n+1} = \lambda \cdot x_n \cdot (1 - x_n) \quad 0 < \lambda \leq 4, x_n \in [0, 1] \tag{1}$$

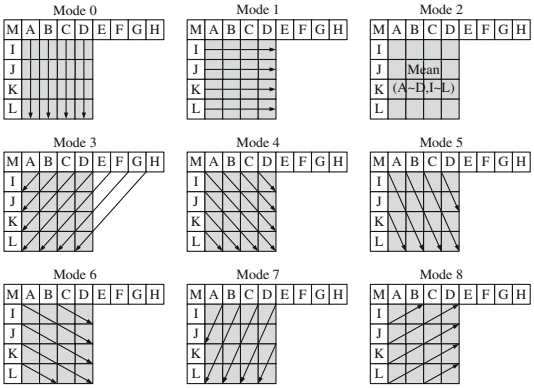

Fig. 2. 9 different predictions

Where, λ is the branch parameter. When we determine the λ, and for any x_0, can iterative out an confirm sequence $x_1, x_2, \ldots, x_n, \ldots$, this sequence vary from the value of λ.

We can distinguish the condition into the follow conditions:

(1) /
(2) When $\lambda = 3.0$, the stable solution bifurcation period is 2.
(3) When $\lambda = 3.449489$, the stable solution bifurcation period is 4.
(4) When $\lambda = 3.544090$, the stable solution bifurcation period is 8.
…

When $\lambda \geq 3.5699456$, the stable solution bifurcation period is 2^{∞}, and system enter the chaotic state. Generally, we always use the chaotic sequence after 500 numbers.

In general, secret information is constructed by 01 sequence, so we must change the sequence from logistic map into 01 sequence. The change method is as follows:

$$x(i) = \begin{cases} 0 & x_i < x_{avg} \\ 1 & x_i > x_{avg} \end{cases} \tag{2}$$

Where, $x_{avg} = \frac{1}{m}\sum_{i=1}^{m} x_i$, m is the total number of the chaotic sequence. Then the chaotic sequence is changed into 01 sequence. Then we can manipulate the secret information with it, the specific method will describe in Embedding algorithm.

3 Video Steganography Algorithm Based on the Intra Prediction Modification

3.1 Selecting Embedding Regions

There has many intra prediction block sizes in H.264, like 16 × 16, 8 × 8 and 4 × 4. Large size blocks (like 16 × 16 block) always use in smooth regions, and details and complex texture area use small size blocks (like 4 × 4 block) to suit. According to the experience, the human eyes are insensitive for the complex texture area and details, so we use 4 × 4 blocks as the region to hide the secret information.

3.2 Embedding Algorithm

Step 1. Pretreating the secret information bits. In order to achieve the flow with less relevance and improve its security, and the method we use must ensure the real-time requirements, so we use stream cipher encryption method to preprocess the secret information. The details are as follows:

$$f_i = m_i \oplus p_i \tag{3}$$

Where, m_i is the original secret information bit, f_i is the processed bit, p_i is the logistic 01 sequences from Sect. 2.2. At this time, the sequence, we get from formula (1) with high security and high randomness characteristics, and we make each two bit into one group.

Step 2. Traverse all the video I-frame, record all intra prediction modes of 4 × 4 blocks.

Step 3. Let each three blocks into a stego-group, and use C_1, C_2, C_3 to represent them. And we use $F_1(x_1)$, $F_1(x_2)$, $F_1(x_3)$ represent the best intra prediction model, or the current prediction model, of C_1, C_2, C_3 respectively. If the parity of $F_1(x_1)$ and $F_1(x_2)$ are the same, then $t_1 = 0$, otherwise, $t_1 = 1$; if the parity of $F_1(x_2)$ and $F_1(x_3)$ are the same, then $t_2 = 0$, otherwise, $t_2 = 1$.

Step 4. Embedding secret information bits. Each embedding process embed one group secret information bits. Within each group there are two bits of secret information, s_1, s_2, we only need to establish the mapping relationship $\begin{cases} t_1 = s_1 \\ t_2 = s_2 \end{cases}$ when we want to hide secret information bit, in order to ensure the establishment this mapping, according to the different initial conditions, adjustments are as follows, as shown in the Table 1:

The method to modify the intra prediction of current block is as follows:

$$sub\_ \bmod e = \arg[\min_{m_j} J(m_j, \lambda_{MODE})] \quad m_j \in S \tag{4}$$

$$S = \{IMODE | IMODE \bmod 2 \neq cur\_ \bmod e \bmod 2\} \tag{5}$$

Table 1. Embedding rules

Initial condition	Modification mode
$t_1 = s_1 \,\&\, t_2 = s_2$	None
$t_1 \neq s_1 \,\&\, t_2 = s_2$	Modify the intra prediction mode of C_1, and inverse with the parity of $F_1(x_1)$
$t_1 = s_1 \,\&\, t_2 \neq s_2$	Modify the intra prediction mode of C_3, and inverse with the parity of $F_1(x_3)$
$t_1 \neq s_1 \,\&\, t_2 \neq s_2$	Modify the intra prediction mode of C_2, and inverse with the parity of $F_1(x_2)$

Where, $sub\_ \bmod e$ is the replacement of the intra prediction mode, $cur\_ \bmod e$ is the current intra prediction mode, $J(\cdot,\cdot)$ is the Lagrangian rate distortion optimization model, the specific formula is as follows:

$$J(S, I|\lambda) = D(S, I) + \lambda \times R(S, I) \tag{6}$$

Where, λ is the Lagrangian parameter, $D(S, I)$ and $R(S, I)$, which indicates the distortion and bit rate of the output stream respectively, the code stream is the output of the sample S using the encoding mode I.

Step 5. Repeat Step 4 until all the secret information is embedded.

3.3 Extracting Algorithm

Step 1. First of all, restore the video sequence from the trans-stream, iterate over I frames from this sequence, and recording all the pieces of the intra prediction mode.
Step 2. We make each 3 blocks as a group, and record them as $C_1^{'}$, $C_2^{'}$, $C_3^{'}$. And now use $F_1^{'}(x_1)$, $F_1^{'}(x_2)$, $F_1^{'}(x_3)$ to represent the current prediction mode of block $C_1^{'}$, $C_2^{'}$, $C_3^{'}$.
Step 3. Extracting the secret information bits, the rules are as formula (7):

$$m(i) = \begin{cases} 00 & F_1^{'}(x_1) \bmod 2 = F_1^{'}(x_2) \bmod 2 \,\&\, \& \, F_1^{'}(x_2) \bmod 2 = F_1^{'}(x_3) \bmod 2 \\ 01 & F_1^{'}(x_1) \bmod 2 = F_1^{'}(x_2) \bmod 2 \,\&\, \& \, F_1^{'}(x_2) \bmod 2 \neq F_1^{'}(x_3) \bmod 2 \\ 10 & F_1^{'}(x_1) \bmod 2 \neq F_1^{'}(x_2) \bmod 2 \,\&\, \& \, F_1^{'}(x_2) \bmod 2 = F_1^{'}(x_3) \bmod 2 \\ 11 & F_1^{'}(x_1) \bmod 2 \neq F_1^{'}(x_2) \bmod 2 \,\&\, \& \, F_1^{'}(x_2) \bmod 2 \neq F_1^{'}(x_3) \bmod 2 \end{cases} \tag{7}$$

Where, $m(i)$ is the secret information group.
Step 4. Repeat Step 3 until all the secret information is extracted.
Step 5. According to the x_0 and λ, we can generate the same logistics sequence like embedding process, and covert them to 01 according to the formula (1), and we do not use pre-500 sequence, the others as the sequence we use in this paper. Then, use the secret information bits extract from Step 4 XOR processing with the logistic 01 sequence, formula is as follows:

$$m_i = f_i \oplus p_i \tag{8}$$

Where, f_i is the secret information bit extracted from **Step 4**, m_i is the original secret information, p_i is the logistics 01 sequence.

4 Experimental Result and Analysis

Our experimental base is X.264. The software we use is Microsoft Visual C++ and MATLAB 2012. The computer's configuration is Core i5, 2.40 GHz, 3.0 GBRAM, etc. The video sequences are downloaded from the website "media.xiph.org", the format of the sequence includes QCIF (176 × 144), Grandma, Salesman, Soccer, and CIF (352 × 288), Stefan, Paris, Mobile. Every sequence has 300 frames, encoding the I frame per 15 frames.

4.1 Analysis of Invisibility

a. Subject analysis of invisibility

Figure 3 shows the comparison of the original frame and the frame after embedding.

Fig. 3. The comparison between the original and embedding ones

From Fig. 3, we can see that the video using our algorithm to embed has good visibility. The video sequences after embedding satisfy the human visual system (HVS).

b. Objective analysis of invisibility

With the peak signal noise ratio (PSNR) used as the measurement of the invisibility judgment, the PSNR can be described as:

$$PSNR = 10 \times \lg \frac{255^2}{MSE} \tag{9}$$

Where, MSE is the mean square error between the original video image and stego-one, the formula is:

$$MSE = \frac{1}{KMN} \sum_{k=1}^{K} \sum_{m=1}^{M} \sum_{n=1}^{N} [f_1(m,n,k) - f_2(m,n,k)]^2 \tag{10}$$

Where, f_1 is the original video image, f_2 is the stego-one, K is the frame number, and $M \times N$ is the size of the video sequence.

The PSNR value of the test sequence has been shown in Table 2 and the results show that the decrease is low after embedding, and the average decline of PSNR value is about 0.970 dB, so our algorithm is better in visibility.

Table 2. The comparison of PSNR value between original and embedding ones

Video sequence	Frame size	Original PSNR/dB	PSNR after embedding/dB	Decrement/dB	The percentage of decrement/%
Grandma	176 × 144	36.87	36.19	0.68	1.84
Salesman	176 × 144	35.92	34.83	1.09	3.03
Soccer	176 × 144	39.15	37.99	1.16	2.96
Stefan	352 × 288	37.86	37.13	0.73	1.93
Paris	352 × 288	39.80	38.91	0.89	2.24
Mobile	352 × 288	40.69	39.42	1.27	2.46

4.2 Analysis of the Modification Rate

The modified rate indicates the ratio between the secret information and the modified carrier number, which is:

$$\alpha = \beta / \gamma \tag{11}$$

Where, α is modified rate; β is the number of 4×4 blocks which intra prediction modes is modified; γ is the number of bits embedded.

In this paper, when we want to hide 2 bits, we only need modify intra prediction mode of 1 block, and then $\beta = 1$, and $\gamma = 2$, then we can get the modified rate $\alpha = 1/2$.

Reference modify 1 intra prediction mode can only embed 1 bit, so it's $\alpha = 1$, and our algorithm has a better performance than it.

4.3 Analysis of the Bit Rate

Detect the bit rate increase (BRI) of our algorithm after embedding. BRI formula is as follows:

$$BRI = \frac{rate' - rate}{rate} \times 100\% \tag{12}$$

Where, $rate'$ is the bit rate of the one after embedding, *rate* is the bit rate of the original one. The results are shown in Table 3.

From this table, we can see the BRI is low after embedding the secret, so our scheme has a low increase of bit rate after embedding.

Table 3. The BRI

Video sequences	Frame size	Before embedding (Kb/s)	After embedding (Kb/s)	BRI (%)
Grandma	176 × 144	602.15	609.44	1.21
Salesman	176 × 144	602.13	608.03	0.98
Soccer	176 × 144	596.28	601.47	0.87
Stefan	352 × 288	1823.89	1852.89	1.59
Paris	352 × 288	1695.47	1723.78	1.67
Mobile	352 × 288	1633.84	1646.42	0.77

4.4 Embedding Capacity

Embedding capacity is an important index to judge the algorithm better or not.

In this paper, embedding capacity is based on the number of 4 × 4 intra-blocks, each 3 blocks can embed 2 bits, so we can compute the capacity as follows:

$$E_c = (B \times 1/3) \times 2 \tag{13}$$

Where, E_c is the embedding capacity, B is the number of 4 × 4 intra-blocks.

So the embedding capacity varies from the frame size and the details of video sequence, like more texture features have more capacity, and the frame size is also like this.

5 Conclusion and Discussion

In this paper, a novel video steganographic algorithm based on intra prediction modification is proposed. We use the intra prediction mode of blocks to hide this secret. First pretreat secret information by logistic sequence, and use intra prediction mode from a block group suit the secret we want to hide, and we change the intra prediction mode by Lagrangian rate distortion optimization model. Experimental results indicate that, our scheme meets good invisibility, low bitrate increase and low modification rate.

Even though we proposed an algorithm meets advantages above, but there also has many work we can do here, like use, blocks to improve the embedding capacity.

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The Teaching Mode of Japanese Literature Course with Multimedia

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Abstract. The Japanese major low grade cultural curriculum "Japan literature curriculum" has a large amount of information, knowledge characteristics, under the multimedia network environment, the teaching can be based on class and combining the principle, before class construction related resources database, inside and outside the class row good research panel, classroom use of Multimedia to improve the teaching of convenience, system and interest, more conducive to reach the Japanese professional course training students "cultural understanding" teaching objectives.

Keywords: Multimedia · Japanese literature course · Intelligent teaching

1 Introduction

In twenty-first Century, the reform of the teaching in Colleges and universities must make use of the multimedia network teaching environment effectively. In 2007, the Ministry of education on further deepening the reform of undergraduate teaching and comprehensively improve the quality of teaching in a number of opinions "made it clear that:" in Colleges and universities to take the information technology as an important means to improve the teaching quality of, to the widespread adoption of information technology in the teaching activities, continue to promote teaching resources construction and sharing, gradually realize the teaching and management of network. With the development of information technology, the application and function of multimedia technology and multimedia materials in the teaching of colleges and universities have received more and more attention.

In addition, the goal of foreign language learning has changed in recent years. In modern foreign language teaching, the relationship between language and culture has been paid more and more attention. Foreign language teaching is no longer a simple explanation of words and grammar, but more and more attention to the cultivation of learners' ability to use language and the cultivation of intercultural communicative competence. Compared with 1990 promulgated the colleges and universities for basic Japanese teaching outline "and the 2001 promulgated the" colleges and universities for basic Japanese Teaching Syllabus (Revised) expression, we can also be found: "culture's understanding ability has been paid more and more attention. Therefore, in many colleges and universities, Japanese majors have set up the

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"Japanese Literature Course", "the history of Japanese culture", "cross cultural communication" and other professional courses required.

2 Start of the Art

Different from English majors, college students majoring in Japanese is from zero to professional learning, in the limited time of four years of learning all kinds of professional courses, to listening, speaking, reading, writing and translating ability, and graduation time to start from the elementary school to the students of English major in English learning, Japanese to employment [1–3]. Which requires university Japanese teaching has the advantages of high efficiency, to achieve high efficiency in the process of teaching needs of teaching means and methods for the corresponding reform, includes keeping pace with the times to explore the multimedia network environment under all kinds of professional courses teaching reform to the degree [4–6], computer multimedia teaching as shown in Fig. 1.

Fig. 1. Multimedia teaching

As to Japanese major undergraduate teaching object of professional and cultural courses, Japanese literature curriculum "is the culture of low grade Japanese professional courses, in content knowledge based mainly, from several aspects: geography, history, society, literature and culture, introduced Japan, with large amount of information, knowledge, not easy to grasp the characteristics of. Moreover, "the Japanese Literature Course" although it is a compulsory course, but the class is little, two classes per week, only with the teacher's oral teaching, both time and effort, and it is difficult to fully understand. Therefore, in order to adapt to the characteristics of this course, we need to focus on improving the students in class and out of class learning enthusiasm and efficiency. In Japanese Literature Courses "teaching should take different with other Japanese professional course teaching pattern.

3 Methodology

Classroom activity is a kind of includes teachers, students, learning materials, the third party involved in the cultural behavior, only the three pronged approach, can do a good job in teaching culture. “Culture teaching needs a wealth of learning materials, the need to establish a positive interaction between teachers and students teaching mode (see Fig. 2), in order to achieve a better teaching effect [7–10]. Through years of teaching practice and hard work, the author thinks that in multimedia, network environment, to form effective professional culture of Japanese professional teaching mode, first of all to establish and use database of Japanese culture, making the course, and then to plan good inside and outside the class teachers’ teaching and students’ learning mode [11], so as to improve the learning convenience, system and interest multimedia computer network teaching environment as shown in Table 1.

Fig. 2. Japanese class interaction between teachers and students

Table 1. Multimedia network teaching environment

Multimedia network teaching based on students	Multimedia network teaching based on teacher
Clear goal	Informing goal
Learning knowledge	Guided teaching
Learning program	Demonstration operation
Program control	Provide feedback
Task research	Design assignment
Skills upgrading	Summary evaluation

3.1 To Sort Out the Rich Cultural Resources, Establish the Resources Database, Improve the Convenience of Learning

Japanese culture is very rich, but the difficulty of the new teaching mode of Japanese literature course is to screen the multimedia data. Teachers create the teaching of useful information from numerous data in the teaching preparation, need to do a lot of work.

Therefore, teachers should not only master of multimedia technology, but also to obtain the information resources classification and choice, decide what information resources in what way appear in the classroom, teachers in class to work hard brainer organizational work [12, 13]. Without teachers' careful planning and design, multimedia assisted teaching is easy to become a mere formality, the teaching effect will be greatly reduced. To explore the teaching mode of "Japanese literature courses should first pay attention to is find the information, editing and finishing work, comb the rich cultural information, pay attention to division of resources module, to create a resource database, improve convenience of learning [14, 15].

Japanese cultural resources is not only the foundation for students to realize personalized learning and self-regulated learning, more is the teacher in the curriculum planning material library, facilitate the according to need or selection, integration of teaching materials, or new knowledge and new development of courseware construction [16, 17]. There is a lot of Japanese NHK TV station of outstanding documentaries. Marriage and other can let us know more about a hotspot issue of Japan. As the teacher should pay attention to, because of the different position of Sino Japanese two countries nor blindly will all have brought on by, in the use of these videos have clips, and to tell the students as the Chinese people should have the attitude and position.

3.2 Organize Internal and External Time, Overcome the Fragmentation of Learning and Improve the System of Learning

Multimedia technology is a two edged sword. It is convenient to collect all kinds of information on the Internet, it is convenient for us to study and live, but also distract the students' attention and impact on the traditional classroom teaching. As a teacher in the information age, should advance with the times, both the use of rich teaching methods, innovative teaching methods (see Fig. 3), but also try to avoid the students' knowledge is too fragmented, improve the system of learning. Tables 2 and 3 show the experimental results of computer multimedia teaching model.

Fig. 3. Online learning Japanese

Table 2. Experimental results of computer multimedia teaching model in general class

	Class	Mean	Std. deviation	Std. error	T	Sig. (2)
Admission score	Ordinary class 1	75.46	3.09	0.43	315	753
Period achievement	Ordinary class 2	79.87	4.12	0.77	304	762
Final exam	Ordinary class 3	78.34	6.43	0.97	139	890

Table 3. Experimental results of computer multimedia teaching model in the experimental class

	Class	Mean	Std. deviation	Std. error	T	Sig. (2)
Admission score	Experimental class 1	80.45	3.19	0.56	342	778
Period achievement	Experimental class 2	81.23	4.23	0.90	378	809
Final exam	Experimental class 3	80.23	6.23	0.87	354	976

"Teaching" is "teaching" and "learning" two-way interaction, both "teaching" considerations, but also need to "learn". According to the Japanese literature courses, the teaching content, according to the nature, history, culture, society, literature of module division, according to different students' interest, divided into different data collection team, student organizations in accordance with the requirements of the teaching goal positive initiative to collect data, found the problem and solve the problem. To stimulate the learning motivation of the students, cultivate students' cooperative attitude, sense of competition and speculative, innovation ability, the zero point of the Japanese students crucial. Knowledge of geography, history, politics, economy, customs, religion, sports, seemingly isolated, and they are closely linked, let the student through the basics of Japanese Literature Courses", a more comprehensive and systematic understanding of Japanese culture. Never rigidly adhere to the textbook, but can't completely out of the text [18, 19]. Learning is not restricted in the classroom, but the full inspiration and interaction in the classroom is essential. Both inside and outside the classroom learning combined to break the traditional professional knowledge, teaching mode, break through the teaching of the limitations, emphasizes the teacher's leading role and students' subjectivity, makes teachers and students as well, the Japanese to enhance teaching and learning efficiency, and depth to culture teaching tends to be better.

3.3 Multimedia Assisted Instruction, Enhance Interaction Between Teachers and Students, Improve Learning Fun

Based on one of the distinctive characteristics of the culture of professional database of multimedia teaching is the teaching content vivid, graphic and luxuriant, fully mobilize all the senses of students, so that students can more thorough understanding of the content of learning, memory even more deep, to improve the learning interest of taste. Multimedia aided instruction, the rich picture, sound, color, animation and other large extent to keep the learning interest of the students do not say, because of its resource sharing, large amount of information, break through the limit of time and space, interactive features such as strong, but also to overcome the traditional teaching of the single,

multi side, multi angle, channel to transfer the Japanese nation, culture, cultivate students' cultural awareness and comprehension ability.

4 Results and Discussion

Japanese literature courses need to make perfect high quality multimedia course, carefully planning each topic inside and outside the classroom learning content and learning mode, teaching content can be through the vivid pictures and authentic pronunciation, so that students take the initiative to absorb knowledge, rather than passively indoctrinated. Such as in Japanese society, involves to the Japanese educational modules can let students to collect data prior knowledge of contemporary Japanese education philosophy of education, the school system, school, schools, teachers and other, guide students to find Japanese education in Japan become an economic power play what kind of role, which is that we should learn from Japanese Education content. Classroom interaction between teachers and students, give students more free space, roaming in a variety of life situations and language environment, be a pleasure to be in, in a pleasant resonate. In resonance to obtain language ability, realizing Japanese professional courses to train students "cultural understanding" teaching objectives

To maximize the expansion of students' cultural awareness and understanding, "survey of the Japanese" new teaching mode of practice excavated under the environment of multimedia network teaching a variety of possibilities: strengthened the construction of Japanese culture resources, construct students through laboratory of Japan the resource database platform preview and review of the project, to make teaching course of Japanese culture and professional course "a survey of Japan" vivid, high quality, explore these follow the pace of the times, enrich the research perspective of Japanese teaching reform and inject new vigor into the culture related professional courses. Teaching effect, teachers and students gain a lot: for teachers and collective lesson planning, classroom effect between teachers and students in the total assessment of form to better enable teachers in the new specialty building faster accumulation of experience, avoid detours, at the same time, through this study is also conducive to improve the teaching of Japanese language education in cultural courses; for students, teaching mode reform to motivate learners to learn Japanese interest and enhance their ability of independent learning, but also will enhance the Japanese Majors' listening and speaking ability, raising the Japanese intercultural communicative.

5 Conclusions

Multimedia network is a kind of carrier, is unable to substitute teachers teach and students learn, so in the exploration of the curriculum, we should also note the application of multimedia technology in teaching and not weaken the teacher's role, but for teachers and students put forward higher requirements in multimedia assisted in view of the characteristics of this course and collecting comb resource. According to the characteristics of the course and the target, combined with the characteristics of students planning a variety of classes inside and outside the learning content and mode, in order

to better to achieve the teaching effect. “Knowledge has no limit, teach the Wuding method.” Cross cultural communication and globalization era, the Japanese teachers should be under the guidance of modern teaching theories, so the Japanese teaching assisted by the multimedia and network technologies, and interesting, so that students in front of perceptual materials more changes to the rational knowledge, for students to provide a more flexible, convenient, practical and broad learning and practice, guide the students to learn.

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Intelligent Optimization Algorithms

Multi-view Discriminative Manifold Embedding for Pattern Classification

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Abstract. While many dimensionality reduction algorithms have been proposed in recent years, most of them are designed for single view data and cannot cope with multi-view data directly. Dimensionality reduction algorithms in recent ten years, both in theory and application have great breakthrough. In the face of dozens, hundreds or even thousands of dimension by dimension reduction to the data from high dimensional space to a low dimensional space and extract the essential characteristics of low dimensional data. In many real-world pattern applications such as face recognition, multiple feature descriptors can provide complementary information in characterizing image from different viewpoints. Motivated by this concern, we propose a new multi-view discriminative manifold embedding (MDME) method for classification by making use of intra-class geometry and inter-class marginal information as well as complementary information of multiple feature representations. Experimental results on face recognition demonstrate the effectiveness of the proposed algorithm.

Keywords: Discriminative manifold embedding · Multi-view learning · Dimensionality reduction · Pattern classification

1 Introduction

Dimensionality reduction is a fundamental problem in many machine learning and pattern recognition applications [1]. Recent researches show that higher dimensional data (such as face image) lie on a low-dimensional nonlinear manifold. To fully discover the manifold structure of high-dimensional data, the most representative manifold learning algorithm is a locality preserving projection (LPP) [2]. Although LPP can preserve the local geometry of samples with a weighted adjacency graph, it is unsupervised and ignores the interactions of samples from different classes. To utilize discriminant information for pattern classification, some supervised manifold learning algorithms have been developed. Despite the various motivations of different manifold learning algorithms, they can be unified into a general graph embedding framework (GEF) [3] with different constraints.

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Data dimension reduction of pattern recognition of face recognition has been widely used. Because usually face image data of high dimension will not only cause the problem of "dimension disaster", but also can make people found it difficult to structure of the underlying data set information. If the data dimension reduction preprocessing, on one hand, can overcome the "dimension disaster" problem; on the other hand can greatly reduce the computational complexity and noise. So data dimension reduction methods now attract the attention of the researchers.

2 Related Work and Background

Most existing dimensionality reduction algorithms assume that the data are represented in a single view. In many practical applications such as face recognition, multiple feature descriptors can provide complementary information in characterizing image information from different viewpoints. Therefore, existing single-view-based methods cannot directly cope with data described with multiple views. Recent studies have shown that leveraging information contained in multiple views potentially has a discriminating advantage over only a single view. Hence, it is more reasonable to incorporate multi-view learning into dimensionality reduction so that the complementary property of different views can be fully exploited for low-dimensional embedding. To achieve this goal, there have been some attempts which include distributed multi-view subspace learning (DMSL), multi-view stochastic neighbor embedding (MSNE), and multi-view spectral embedding (MSE) [4].

Although DMSL and MSNE can obtain low-dimensional embedding from multi-view high-dimensional data, they are unsupervised and classification abilities may be limited, since the class label information is not used in the learning process [5]. While MSE can solve the multi-view subspace learning problem by using the "patch alignment framework", it ignores the flexibility of allowing shared information between different views owing to the global coordinate alignment process [6]. More recently, multi-view subspace learning has been successfully applied to image annotation, cartoon retrieval and synthesis. By jointly considering the local manifold structure and the class label information, we propose a new method, called multi-view discriminative manifold embedding (DME) [7]. Experimental results on face recognition are presented to demonstrate the effectiveness of the proposed approach [8].

The human face is one of the most common mode of people's vision, face recognition have attracted much attention because of its non-contact, safe, natural, intuitive and convenient characteristics and has become one of the biometric identification technology currently. Face recognition is currently a hot research topic in the field of artificial intelligence and pattern recognition [9]. Extracting effective features (data dimension reduction) plays a key role in the pattern classification of high dimensional data. According to the biometric recognition of the human face, the dimension reduction algorithm directly affects the recognition rate of face recognition [10].

3 Proposed Approaches

In face recognition, generally use a high dimensional vector to represent an image, but because of the face recognition feature dimension is too high and not stable, dimension reduction is the most common method to solve this problem. The extraction of effective features is the key to reduce the impact of loss of information on the recognition rate [11, 12]. Dimensionality reduction (feature extraction) simply by mapping function (including nonlinear mapping and linear mapping) mapping high-dimensional data into low dimensional space, reduce the data dimension, reduce the time complexity of the algorithm and extract the essential features of the data, for data classification and visualization analysis etc. So far, many linear and nonlinear dimensionality reduction methods have been proposed.

Recent studies show that although the different data dimensionality reduction algorithms based on different theories and methods, they also have some contact. So expect data dimensionality reduction methods into a unified framework to discuss and research [13–15], through this framework to a certain extent, can promote dimension reduction algorithm.

Given a multi-view data set consisting of n samples with m different features is denoted as a set of matrices $X = \left\{X^{(i)} \in R^{p_i \times n}\right\}_{i=1}^{m}$, wherein $X^{(i)}$ is the feature matrix of the ith view representation, p_i is the dimensionality of the ith view $X^{(i)}$. The aim of MDME is to seek a low-dimensional and sufficient smooth embedding $Y^{(i)} \in R^{d \times n}$ of $X^{(i)}$ via $Y^{(i)} = V^T X^{(i)}$, where in $d < p_i$ $(i = 1, 2, \ldots, m)$.

In order to well explore the complementary information of multiple views for feature extraction, a set of nonnegative weights $\beta = [\beta_1, \beta_2, \ldots, \beta_m]$ is imposed on the objective function of DME of each view. The larger β_i is, the more contribution of the view $X^{(i)}$ makes learning the low-dimensional embedding. Hence, by summing over all views, the optimal objective function of MDME can be formulated as follows.

$$\max_{V,\beta} J(V, \beta) = J_1(V, \beta) - \alpha J_3(V, \beta) = \sum_{i=1}^{m} \beta_i Tr\left(V^T H^{(i)} V\right) \tag{1}$$

With the constraint

$$V^T V = I, \quad \sum_{i=1}^{m} \beta_i = 1, \quad \beta_i \geq 0. \tag{2}$$

$$H^{(i)} = \left(X^{(i)} L^{(i)} X^{(i)^T} - \alpha X^{(i)} \left(I^{(i)} - R^{(i)}\right) \left(I^{(i)} - R^{(i)}\right)^T X^{(i)^T}\right) \tag{3}$$

The solution to (2) subject to (3) is $\beta_i = 1$ corresponding to the maximum $Tr\left(V^T H^{(i)} V\right)$ over different views, and $\beta_i = 0$ otherwise. This means that only the best view is finally selected by our method, thus resulting in failing to exploit the complementary information from different views for dimensionality reduction. To tackle

this problem, following the trick adopted in, we modify β_i to be β_i^q with $q > 1$. Then, the new objective function is defined as follows.

$$\max_{V,\beta} \sum_{i=1}^{m} \beta_i^q Tr\left(V^T H^{(i)} V\right), \quad \text{s.t.} V^T V = I, \sum_{i=1}^{m} \beta_i = 1, \beta_i \geq 0. \tag{4}$$

Since (7) is a nonlinearly constrained nonconvex optimization problem which has no closed-form solution, we derive an alternating optimization-based iterative algorithm to obtain local optimal solution.

First, we fix V and update β. By utilizing the Lagrange multiplier λ to incorporate the constraint into objective function, we obtain the following Lagrange function:

$$L(\beta, \lambda) = \sum_{i=1}^{m} \beta_i^q Tr\left(V^T H^{(i)} V\right) - \lambda\left(\sum_{i=1}^{m} \beta_i - 1\right) \tag{5}$$

Let $\partial L(\beta, \lambda)/\partial \beta_i = 0$ and $\partial L(\beta, \lambda)/\partial \lambda = 0$, we have

$$\beta_i = \left(1 \Big/ Tr\left(V^T H^{(i)} V\right)\right)^{1/q-1} \Big/ \sum\nolimits_{i=1}^{m} \left(1 \Big/ Tr\left(V^T H^{(i)} V\right)\right)^{1/q-1} \tag{6}$$

Then, we update V by using the obtained β. The optimal problem (7) is equivalent to

$$\max_{V} \sum_{i=1}^{m} Tr\left(V^T H^{(i)} V\right), \quad \text{s.t.} V^T V = I. \tag{7}$$

and V is given by the maximum eigenvalue solution to the eigenvalue problem.

$$\sum_{i=1}^{m} H^{(i)} V = \lambda V \tag{8}$$

4 Experimental Results

In this section, we evaluate the effectiveness of our proposed MDME approach for face recognition task. We also compare the proposed algorithm with some traditional single-view- based dimensionality reduction algorithms, such as PCA, LDA, LPP, and MFA, as well as the three latest multi-view dimensionality reduction algorithms, including DMSL, MSNE, and MSE. For a fair comparison, all the results reported here are based on the best tuned parameters of all the comparison algorithms.

We have used the ORL and AR face databases in our experiments. The ORL database contains 400 images of 40 people. Each person provides 11 different images with various facial expressions and lighting conditions. The AR database contains over 4000 face images of 126 people (70 men and 56 women). For all the images in the above two databases, the facial parts of each image was manually cropped, aligned, and

resized to 32 × 32 pixels according to eye's positions, with 256 gray levels per pixel. In order to comprehensively describe face images, we extract three kinds of low-level visual features to represent three different views, i.e., SIFT, Gabor, and LBP features. Because the three views are generally complementary to each other, we empirically set q in MDME to 5. The dimensionality of the low-dimensional subspace d is set to 20 for ORL database and 30 for AR database. Table 1 tabulates the rank-1 recognition rates of different methods with different features on the ORL and AR databases.

From the experimental results listed in Table 1, we can observe that the proposed MDME method significantly outperforms other multi-view and single view methods on the two databases, which implies that extracting the discriminative feature space by making use of intra-class geometry and inter-class marginal information and explicitly exploring the complementary characteristics of different visual features can achieve the best recognition performance. As shown in Fig. 3.

In our proposed MDME algorithm, the parameter α is empirically set to 1 in the previous experiments. To investigate the influence of different choices of α, Fig. 1

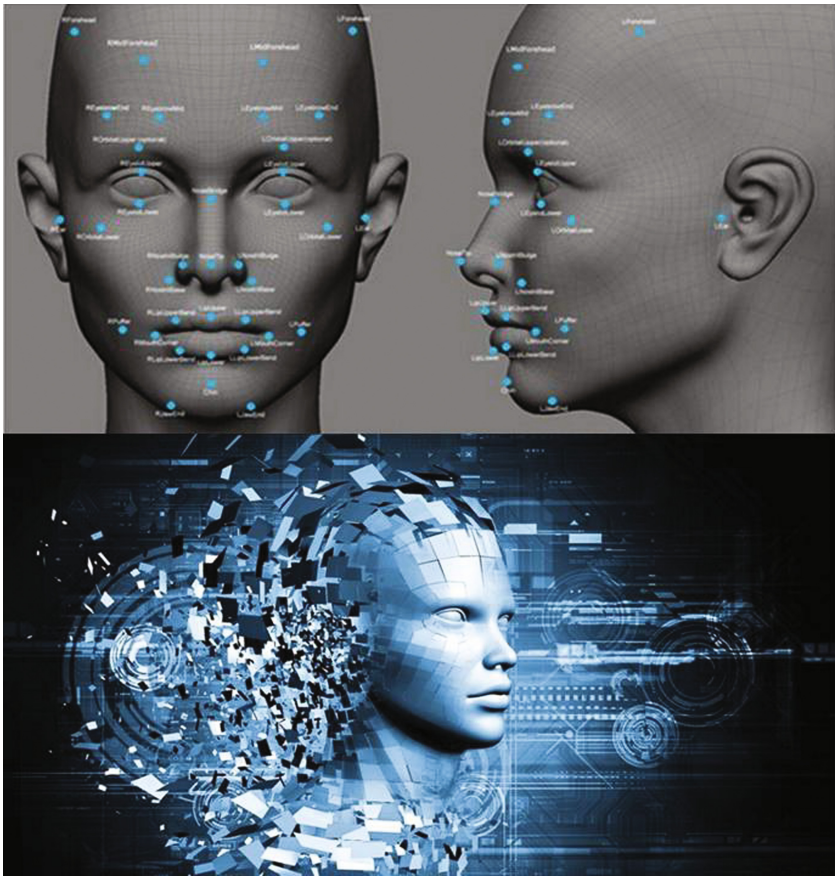

Fig. 1. Face recognition

shows the recognition rate of MDME versus different values of α, we can observe that MDME demonstrates a stable recognition performance over a large range of α. Hence, the parameter selection is not a very crucial in MDME algorithm. In addition, since MDME is an iterative algorithm, we evaluate its recognition rate with different number of iterations in Fig. 2. As can be seen, our proposed MDME algorithm can converge to a local optimal value in less than 5 iterations.

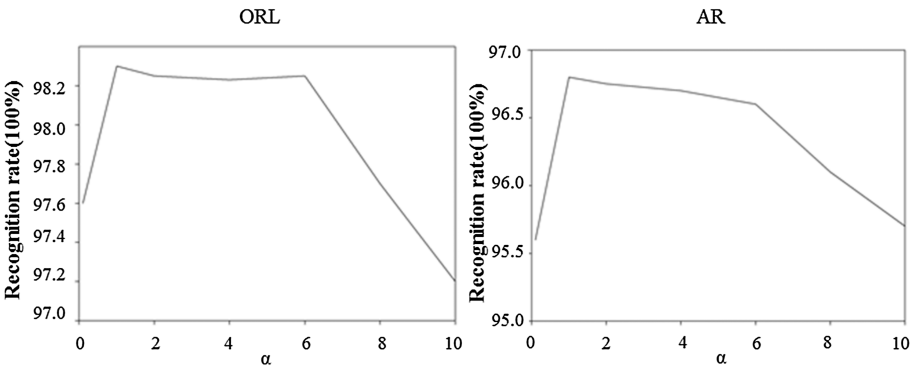

Fig. 2. Recognition rate versus α in MDME on ORL and AR databases.

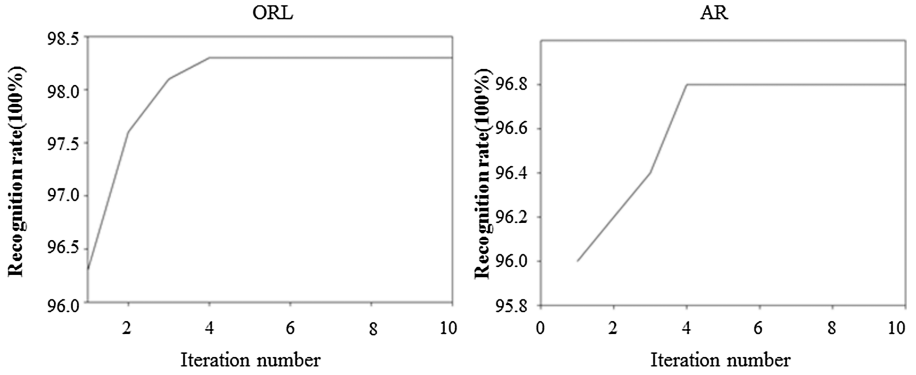

Fig. 3. Recognition rate versus iteration number in MDME on ORL and AR databases.

5 Conclusions

Data reduction is an important step towards the process of large data processing, and has become a hot research topic in the field of pattern recognition.

Feature extraction cannot only find the meaningful low dimensional structure information in high dimensional data, but also can reduce the impact of the curse of dimensionality to a certain extent, and promote the visualization and classification of data. Face recognition technology brings us to a lot of convenience, it has a wide range

of application prospects. The development of face recognition technology not only improve the security of electronic technology products, but also can promote the development of artificial intelligence, image processing, computer graphics, cognitive science and psychology and other disciplines. Because the face structure model is too complicated and diverse, and easily influenced by illumination, facial expressions, gestures and other factors, how to effectively extract features to achieve the purpose of dimension reduction is the key in face recognition. Graph embedding framework is a better unified manifold learning linear dimension reduction algorithm and nonlinear dimensionality reduction algorithm, in order to understand the difference between the dimension reduction algorithm and the link is very helpful.

This letter proposes a new manifold learning algorithm, called multi-view discriminative manifold embedding (MDME) for feature extraction and classification. Compared with the conventional single-view-based subspace learning algorithms, MDME can consider local geometry and discriminative information as well as complementary information of multiple feature representations to obtain an effective low-dimensional embedding. Experimental results on two face databases have demonstrated the efficacy of the proposed approach..

Above is the main work done in this paper, although in the dimension of data reduction researchers has made some achievements, but there still some deficiencies, so we need to continue to study the research direction, the complexity of the algorithm.

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Network Time Balance Management Based on TFRR Optimization Algorithm

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Abstract. Network coordination work based on IEEE802.11 protocol will form a network blocking phenomenon when it was accessed into channels at a same site and the same site and with the same rate. According to the analysis of network throughput and fairness theories, this paper presents an optimization algorithm based on the accessibility of TFRR algorithm to network balance, so as to improve the network working performance and avoid the occurrence of channel blocking phenomenon through the round robin queue of adjustable time for. And the tests show that the theoretical basis of the algorithm is feasible in practice with a pure quadratic function, the minimum is reached within *N* iterations (excepting round-off error), but a non-quadratic function likely to makes slower progress. The subsequent search directions lose noncompliance requiring the search direction to be reset to the steepest descent direction at minimum for every *N* iterations, or earlier if the progress is contained. If every iteration is reset, then it turns it to the steepest. The algorithm will not work if it gets the minimum, determined when there is no progress after a direction reset (i.e. in the steepest descent direction), or if any tolerance criterion is reached. Within a linear approximation, the parameter α {\displaystyle \displaystyle \alpha} and the parameter β {\displaystyle \displaystyle \beta} are equal in the linear conjugate gradient method and they get the line searches. The conjugate gradient method will follow the narrow or ill-conditioned valleys and the steepest descent method slows down which follows a *criss-cross* pattern.

Keywords: TFRR algorithm · WLAN network · Network time balance

1 Introduction

The existing WLAN network supports 802.11a/b/g/n/ac protocols, and the multi rate WLAN will lead to the high rate of the rate of the performance of the site and the low rate of the site to maintain consistency, resulting in abnormal performance. This is due to that CSMA/Ca mechanism adopted by the 802.11 protocol essentially provides each site with equal probability of access channel without distinguishing the transmission rate of the sites, while the low rate stations will take more time to channel resources to transmit data frames of the same size, thus reducing the system efficiency in the use of resources at the same time, but also led to the unfairness of the higher rate stations

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Aiming at the problem of abnormal performance of multi rate WLAN, a large number of literatures have proposed different system optimization algorithms based on time fairness [1, 2].

A new trust region method is presented, which combines no monotonic line search technique, a self-adaptive update rule for the trust region radius, and the weighting technique for the ratio between the actual reduction and the predicted reduction. Under reasonable assumptions, the global convergence of the method is established for unconstrained no convex optimization. Numerical results show that the new method is efficient and robust for solving unconstrained optimization problems [3].

In this paper, does not modify the MAC layer access parameters as the premise, this paper puts forward a linear time-adjustable fair cycle queue polling scheduling algorithm (it must be fairness round robin, torr) to ensure the UDP/TCP downlink and uplink TCP link time fairness at the same time, and can effectively improve the system throughput performance.

2 System Model and Theoretical Analysis

A typical basic WLAN network is managed by an AP and accessed by *N sta* wireless, and *stas* in different channel environments will select the optimal sending rate through adaptive rate, eventually leading to a network with multiple transmission rates.[7] Different fairness mechanisms have seriously affected the performance of multi rate WLAN systems. The following is a detailed theoretical analysis and performance comparison of throughput fairness and time fairness [4, 5].

Assuming that the transmission rate of A is At, the transmission length is N, and the data frame time, but can be expressed as

$$B_t = A_{ov} + \frac{N}{A_r} \tag{1}$$

Where, the *Aov* is fixed redundancy overhead, including the physical layer preamble transmission time, feedback frame channel occupancy time, short frame between interval and distributed coordination function frame interval, and the average backoff time [6].

If the sites are strictly following the CSMA/CA competitive access mechanism, the access channel can be guaranteed completely consistent, and the throughput fairness of each site can ultimately achieved. In the saturation state, each site is connected to a channel, and the sum of the time is

$$T = \sum_{t=1}^{M} A_t \tag{2}$$

During the period of T, the throughput of M data frame is transmitted in a fair condition, and the system saturation throughput is

$$S_1 = \frac{M \cdot N}{T} = \frac{M \cdot N}{\sum_{t=1}^{M} A_t} \tag{3}$$

If we use the time fairness mechanism, the time of each site access channel is consistent, the channel time allocated by each site is T/N, and the system saturation throughput rate of T can be obtained

$$S_2 = \left\{ \sum_{t=1}^{M} \frac{(T/M) \cdot N}{A_t} \right\} / T = \frac{N}{M} \cdot \sum_{t=1}^{M} \frac{1}{A_t} \tag{4}$$

The ratio of the system saturation throughput is compared between the fairness of time fairness and throughput fairness, such as the Formula (5), when and only when t1 = t2 = … = tN the equation is established, at this time, it also means that A1 = A2 = … = AN. It can be known that for multi rate WLAN, the system throughput performance (S2) under the time fairness condition is greater than that of the system performance (S1). Therefore, this paper focuses on the mechanism of temporal fairness, and puts forward the corresponding optimization algorithm.

$$S_1 = \frac{M \cdot N}{T} = \frac{M \cdot N}{\sum_{t=1}^{M} A_t} \tag{5}$$

3 TFRR Algorithm Based on Time Fairness

3.1 Effective Remaining Time Update

The effective residual time update involves 3 processes: the initialization of the queue, the polling period and the end of the polling period. When the site I through the AP authentication and associated operations, AP will initialize a cache queue for the destination site, and the remaining time is set to its effectiveness,

$$TA^{(t)}(0) = TimeUnit \tag{6}$$

Among them, Time Unit is the unit service time of each polling site, which is referred to as TU (see Fig. 1).

In the polling cycle K, AP real-time statistics of each site is occupied by the wireless channel time, containing up/downlink traffic, the corresponding AP end receive/send events, the channel time occupied by each data frame using the calculation of Formula (1). And then update the receiving/sending data frame corresponding to the remaining time of the site queue, the update process, such as the Formula (7), which, TTX, TRX, respectively, to receive, send data frame channel occupancy time (see Fig. 2).

$$TA^{(t)}(K) = \begin{Bmatrix} TA^{(t)}(K) - T_{RX} \\ TA^{(t)}(K) - T_{TX} \end{Bmatrix} \tag{7}$$

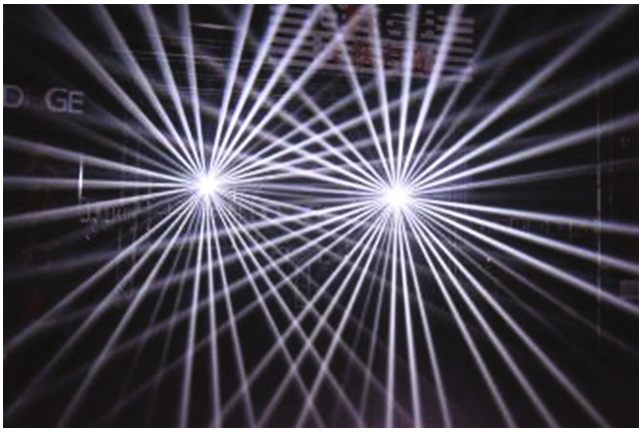

Fig. 1. The linear variation

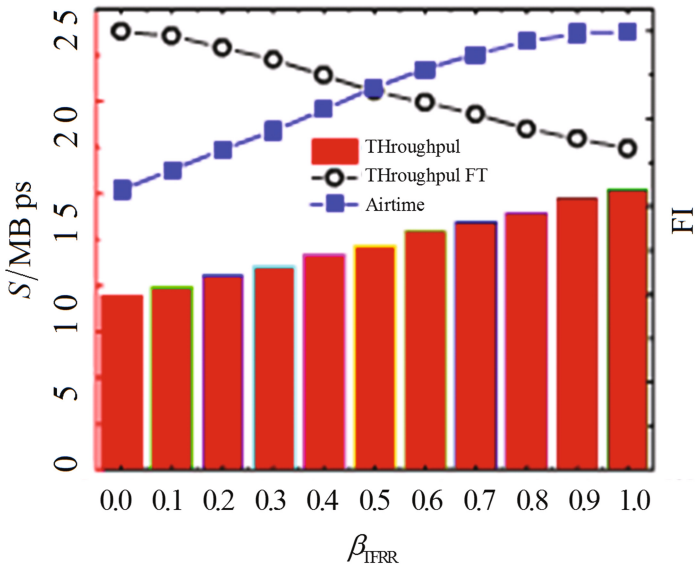

Fig. 2. The linear tuning after fair

While the polling cycle K ends (RndComplete), the AP will once again update the valid remaining time of all site queues

$$TA^{(t)}(K+1) = a^m \cdot TA^{(t)}(K) + TU \tag{8}$$

The alpha is the history of the residual coefficient, which is usually set less than or equal to 1/2 to ensure effective spare time only in the short term the transmission effect and an exponentially decreasing with time [7, 8]. N represents the number of times the I continuous queue is empty. This means that if a site has no data communication with

AP for a long time, its effective residual time will tend to be stable value of Time Unit. Under the condition of flow, saturation, the scheduled service time of each station will be consistent, and the time between each station will be fair [9, 10].

3.2 Delay Evaluation

TFRR algorithm increases the delay evaluation function module. The module can select the appropriate unit service time, according to the current active station points (NSTA) and the time limit of the site. Under the condition of flow, saturation, a full polling period *Tpoll* can be expressed by the Formula (9)

$$T_{poll} = N_{sta} \times TU \tag{9}$$

On the one hand, the greater the unit service time, the longer the polling cycle, which can result in an increase in service interval, and affect the performance of specific traffic delay; on the other hand, the smaller unit service time, the shorter each site service assigned transmission time, thus reducing the MAC layer transmission efficiency, especially of the sites supporting 11n/ac protocol frame aggregation function. In summary, under the premise of ensuring all the business flow of QoS, the largest unit of service time should be chosen to improve the efficiency of data frame transmission. Therefore, this paper uses the update method as shown in the Formula (10), in which Dmin is the minimum transmission delay limit for all traffic flows.

$$TU \leq \frac{d_{\min}}{N_{STA}} \tag{10}$$

3.3 Linear Adjustable Fair

Time fairness algorithm can avoid the abnormal performance of the multi-rate network by limiting the consistency of each access channel time, which can improve the throughput performance of the whole system. This is realized, however, at the cost of reducing the throughput of low rate of the site. In the case of flow, saturation, it will lead to extreme unfairness of throughput rates between the low rate site and the high rate site. In some application scenarios, such as airports, coffee shops and other public places, will benefit from lifting performed by time fairness algorithm; whereas in some other application scenarios, such as emergency communication places, it is more likely to have a performance stability which can be induced by throughput fairness [11]. Therefore, in order to meet the needs of different scenarios, this paper employs a linear adjustable fair mechanism. First come, first serve FCFS and short operation priority and short operation SJF process priority scheduling algorithm First come, first service and short operation process priority scheduling algorithm 1, experimental purposes Through this experiment, to deepen understanding of the concept of process, further grasp the process status, process scheduling strategy and the performance of the system of evaluation method. 2, demand analysis (1) input and the range of input values in the form of the input values: process number Num input Num is a process of the arrival time in turn

Please input Num is a process of service time range: 0 < Num < = 100 range: range: input to use algorithm (1 - FCFS, 2 - SJF) range: 1 or 2 output variables (said) (2) in the form of lose

4 Experimental Verification

In order to verify the feasibility of the TFRR algorithm, a hardware system testing platform is established, including one AP and two STAs. All nodes use the Atheros-integrated AR5212A wireless module PC. When transplanting the source driver software Madwifi, it can support the 802.11a/b/g IEEE protocol [12]. On its rate, it adapts the selection of AMRR algorithm, and the optimal transmission rate of two STAs is 54 Mbps and 6 Mbps. Two queue scheduling algorithms, RR and TFRR are achieved at AP port, and they are put in the hardware system for the actual analysis. The saturated UDP and TCP throughput performance of the RR and TFRR algorithms are tested by Iperf software respectively, and the measured results are shown in Fig. 3. Whether with UDP flow or by TCP flow, RR algorithm can ensure the fairness of each site's throughput, but TFRR algorithm ensures the performance of the ratio of the site's throughput fairness on the basis of time fairness. Then this directly leads to the system UDP and TCP throughput performance of TFRR algorithm, compared to those of RR algorithm, have improved by 107% and 96.5%. CM connection management: CM connection consists of CC call control, SMS management sublayer (GSMS) short message service, SM session management and SS supplementary services such as control of the network to provide business, provide and support. GPRS tunnel protocol interface between GTP is used to make GSN node. GTP agreement made by the GTP control made of surface and the surface of the user agreement [13, 14]. The GTP protocol control plane made complete mobile station MS grouping network access to the channel control and management functions, mainly performed to establish, modify, and delete news GSN tunnel between function, at the same time is also responsible for the GSN node mobility management, position management, and path between management functions. GTP

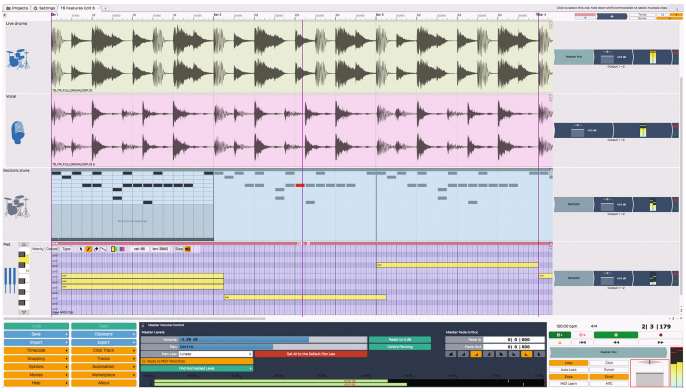

Fig. 3. The testing effects of TFRR algorithm.

agreement made user plane is responsible for data transmission in the tunnel, and transfer the part of the tunnel maintenance function.

5 Conclusion

In this paper, the performance of multi-rate WLAN network is analyzed on the condition of time fairness, and a cyclic polling queue scheduling algorithm (TFRR) with linear adjustable time fairness is proposed. The algorithm not only uses the time fairness between different rate stations to improve the throughput performance of the system, but also gives attention to the transmission delay of the data frame. At the same time, in view of the demands of different application scenarios, it also supports the linear adjustable fairness mechanism to achieve the trade-off between throughput and fairness. Finally, the effectiveness and feasibility of the algorithm are verified by NS-3 simulation and hardware system test.

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Application of Optimized Genetic Algorithm in Building Energy-Saving Optimization Control

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Abstract. As the concept of low carbon and green enjoys popular support, how to construct an energy-saving building system in the modern building project has gradually become a research hotspot in the industry. Based on the above background, this paper proposed an adaptive loop optimized genetic algorithm. On the basis of fully expounding the principles and advantages of this algorithm, this paper took residential housing in Xiangyang for example, introduced such optimized genetic algorithm and constructed a full set of building energy-saving optimization control system. The calculation and application results indicate that this optimized genetic algorithm can achieve bi-directional optimal control of building energy consumption and construction cost, and has good Adaptivity and portability.

Keywords: Optimized genetic algorithm · Energy-saving optimization control · Construction cost · Energy consumption

1 Introduction

The energy-saving building overall takes into account of potential energy consumption, pollution factors in the building project construction, development and use processes and aims to adopt scientific methods to reduce energy consumption output to the largest extent so as to achieve energy-saving development of building system [1]. In recent years, the energy-saving building has become a main development direction of modern construction project. Construction of sound building energy-saving control system with genetic algorithm becomes a research hotspot in this industry. For example, researchers [2] adopted the genetic algorithm of preferential approaching to conduct energy-saving optimization of buildings in the Mediterranean region. Someone studied the influence of air tightness on building energy consumption [3]. On this basis, he applied the traditional genetic algorithm to construct airtight energy-saving model. Someone overall considered the influence of peripheral structure on building energy conservation and applied the traditional genetic algorithm to construct energy-saving design indicator system [4].

The researches of the above scholars verify the application value of genetic algorithm in building energy-saving optimization control. But, most scholars adopt the traditional genetic algorithm as the research method. The largest defect of such genetic algorithm

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is that, it is difficult to achieve the adaptive adjustment, because the analysis is based on the model set. Once the model has a defect in the specific calculation, it is necessary to revise the model manually for secondary calculation. This undoubtedly reduces the operation efficiency [5]. This paper proposed an adaptive loop optimized genetic algorithm. Such algorithm has strong adaptivity, and can automatically cycle calculation of energy-saving indicators and converge continuously until the optimal energy-saving result appears. Thus, this algorithm has strong advancement.

2 Analysis of the Adaptive Loop Optimized Genetic Algorithm

2.1 Algorithm Principle

When the traditional genetic algorithm is used to calculate, it is necessary to carry out operator selection, intersection and variation through constructing an appropriate initial population, and form a new population. On this basis, iteration inspection of the advantages and disadvantages of the objective function is implemented. Finally, the optimal result is chosen [6]. The advantage of the above algorithm is very significant, but it also has some defects. Its biggest defect is that it cannot adaptively compute simulation. Thus, the iteration inspection process of the traditional genetic algorithm is mostly based on manual mode operation. The optimal result often appears after a long time. Thus, the efficiency is too low. Adaptive loop optimized genetic algorithm is a new genetic algorithm which adds parameter module, simulation module and adaptive module based on a traditional genetic algorithm. In practical application, it can gain the optimal solution through simulation calculation and cycling adaptive convergence. The whole proves entirely achieves intelligence and automation. Thus, it has strong advancement [7, 8].

2.2 Optimization Process

The application process of adaptive loop optimized genetic algorithm is as Fig. 1.

As shown in the Fig. 1, adaptive loop optimized genetic algorithm adds simulation calculation, cyclical selection, intersection and variation on the basis of traditional algorithm. On the one hand, the simulation calculation can prejudge the feasibility of operating results through simulation before the final result comes out, and achieves optimization control in advance. On the other hand, the introduction of cyclical adaptive selection, intersection and variation links achieves inspection of output result optimality. In the continuous loop computation process, the optimal result can be automatically generated. Thus, compared with a traditional genetic algorithm, such algorithm has higher intelligence and automation degree and greatly improves operation efficiency.

3 Energy Consumption Cases of Urban Residential Buildings (Excluding Heating in the North) in China

Unit-area energy consumption of urban residential buildings continues to increase slowly. On the one hand, the types and quantity of domestic energy-using devices rise

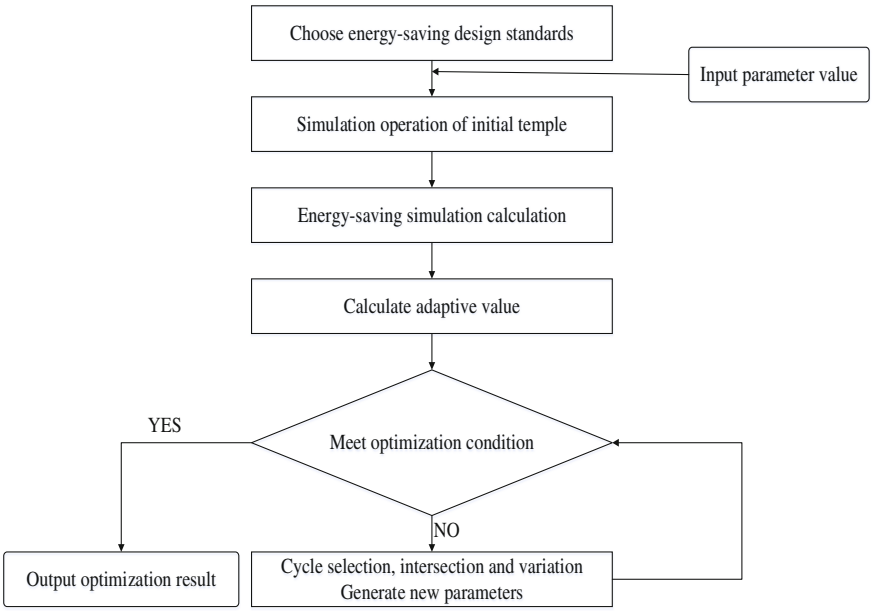

Fig. 1. Process of adaptive loop optimized genetic algorithm

significantly, and the demand for energy use increases; on the other hand, the efficiency of cooking utensils, household appliances, lighting devices and so on improves, which slows down the growth speed of energy consumption. In 2010, energy consumption of urban residential buildings (excluding heating in the north) reached 164 million tec, accounting for 24.1% of building energy consumption. As the urbanization process develops, more than 70% of the population will live in cities and towns in the future. A total area of the urban residential building will increase greatly. Under rational development of urban residential buildings, it is predicted that the building area will increase to 24 billion m^2 from current 14.4 billion m^2.

4 Building Energy-Saving Optimization Control Case in Xiangfan

4.1 Brief Introduction to the Project

Baiyang Oudian Project is a comprehensive commercial residential building project which was developed by Xiangyang Baiyang Real Estate Development Co., Ltd. in February 2014. The overall floorage of this project is 200,000 m^2; the plot ratio is 2.99 and the greening rate is 35%. The project is located at the East Qinghe Bridge, Hangkong Road, Xiangzhou District, Xiangyang City. The project has 20 sets of standard residential houses. To embody the concept of green and energy conservation, the developer adopted green and energy-saving control method during design sand construction of No. 15-18 buildings. The specific energy-saving design and operation process was completed by adaptive loop optimized genetic algorithm. Figures 2 and 3 optimal control

cases of residential building energy conservation in Xiangfan – building effect picture of Baiyang Oudian.

Fig. 2. Optimal control cases of residential building energy conservation

Fig. 3. Optimal control cases of residential building energy conservation

4.2 Setting Energy-Saving Standards

Before the application of the specific genetic algorithm, relevant energy-saving design standards should be chosen according to building energy-saving design situation in Xiangyang. In this paper, energy-saving design standards are chosen for this project in accordance with local standards of Hubei Province DB42/T 559—2013 Energy-saving

Design Standards of Residential Buildings with Low Energy Consumption, and climatic conditions of Xiangyang.

The Table 1 shows energy-saving design indicators chosen for the project as per national standards. The initial design values are selected within the scope of standard values of building energy-saving design. When the loop optimized genetic algorithm is applied for calculation, cyclical test is required according to the indicators chosen above to make sure the final result is optimal and complies with energy-saving building design and construction standards in Xiangyang.

Table 1. Scope of energy-saving design standards and provisions

Design standard	Initial design value	Standard value
Thermal performance of outer wall	K = 0.454, D = 2.614	K < 0.65, D > 2.35
Thermal performance of house surface	K = 0.389, D = 3.241	K < 0.45, D > 2.75
Wall-window ratio	0.193	South < 0.45, East, West, North < 0.28
Thermal performance of external window	K = 1.93	K < 1.98
Illumination intensity	Density 6 W/m^2 (illumination 110lx)	Density < 8 W/m^2 (illumination changes with the different functional zone)
Heating and air conditioning system	Winter COP = 2.3, summer COP = 3.3	Winter COP > 2.1, summer COP > 3.0

4.3 Initial Standard Sample Simulation

To make the precision of genetic algorithm more accurate, Design Builder software was applied to simulate the set energy-saving indicator samples. Design Builder software is a kind of building simulation software developed by the Britain Design Builder Software. It can simulate energy-saving indicators of building projects and offer a basis for architectural designers in energy-saving design. In this paper, the above software was applied to simulate operation of annual building energy consumption and cost of this project, the final results are shown in the Table 2.

Table 2. Simulation results of initial building energy consumptions of building project

Energy consumption type	Energy consumption/kWh	Energy consumption intensity/(kWh/m^2)	Construction cost/ Yuan
Comprehensive energy consumption of wall, house and windows	3214.56	34.14	12578,456
Indoor illumination	578.32	5.78	5436,654
Heating and air conditioning	12124.59	121.24	4325,343

As shown in the above table, after Design Builder software was applied to simulate initial standard samples of this project, annual average output in energy-saving construction and later maintenance process, and the construction cost spent to reduce energy consumption were gained. The simulation results show that, to achieve effective control of building energy conservation, the targeted optimal solution to the above energy consumption and energy consumption intensity must be gained by adaptive loop optimized genetic algorithm.

4.4 Adaptive Loop Simulation Operation

The above initial standard sample simulation results serve as the factors of adaptive loop optimized genetic algorithm to carry out corresponding operation. The specific optimal parameters are set as follows: intersection probability = 0.9; mutation probability = 0.03; the largest iteration times 120, population quantity 250. Relevant operational models are as follows:

Maximum energy-saving efficiency:

$$\text{Umax} = (\text{Emax} - \text{Er})/\text{Er} \tag{1}$$

Maximum cost increment:

$$\text{Smax} = (\text{Cmax} - \text{Cr})/\text{Cr} \tag{2}$$

Average energy-saving efficiency:

$$\overline{U} = \sum_{i=1}^{n} \left(E_i - E_r\right)/nE_r \tag{3}$$

In the formulas 3, Er is annual energy consumption of buildings in this project; Emax is the maximum annual energy consumption in the optimization schemes; Ei is the annual energy consumption of the ith optimization scheme; Cr is construction cost of buildings in this project; Cmax is the maximum construction cost in the optimization schemes; Umax is the maximum energy-saving efficiency; Smax is the maximum cost increment; $\overline{\text{U}}$ is average energy-saving efficiency. After the above model was imported by the computer, the optimal result was converted continuously in the adaptive loop calculation process as shown in Fig. 1. The final result was finally gained: Umax = 0.381, Smax = 0.0335, = 0.278. The above results show that if the optimal result of the adaptive loop genetic algorithm is introduced in the design, construction and operational maintenance stages of this project, 3.35% incremental cost can be utilized to reduce 38.1% + 1% building energy consumption so as to achieve energy-saving control of buildings, while average energy-saving efficiency (0.278) indicates that the result of the above optimization scheme deserves expectation.

4.5 Optimization Control Result

According to optimization operation results, the final energy-saving control scheme can be summarized as follows:

Firstly, 3.35% investment cost in expenditure item construction is used to construct comprehensive energy consumption of wall, house and window, indoor illumination energy consumption and heating and air conditioning energy consumption control system. The result of 3.35% is gained through an adaptive loop genetic algorithm. Thus, it is the maximum cost expenditure ratio of energy-saving control of this project.

Secondly, the computer system is adopted to test energy consumption reduction level in energy-saving construction and operational maintenance. The test items include: comprehensive energy consumption of wall, house and window, indoor illumination energy consumption and heating and air conditioning energy consumption. The test data should be recorded and counted. The results prove that energy consumption reduction ratio of this project is 38.7%, which conforms to the calculation conclusion of the adaptive loop genetic algorithm.

5 Conclusion

Case study in this paper verifies that the application of the adaptive loop genetic algorithm in the design and control of energy, conservation of a building project can greatly improve design efficiency, overall consider construction cost expenditure of the project and offer the optimal energy-saving design scheme under the constraints of low energy consumption and the lowest construction cost. Moreover, such algorithm achieves adaptive process through the simulation operation, and its intelligence operation is stronger. Therefore, the introduction of such algorithm in modern building project energy-saving design is quite feasible.

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Demonstration of SVM Classification Based on Improved Gauss Kernel Function

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Abstract. This article carries on the analysis in view of the Gaussian kernel function among many kernel function support vector machine, which explains the scope of application of Gaussian kernel function and design discriminant algorithm whether sample data for the Gaussian distribution. Select the square of Hilbert space as standards of separability measure data. The design maximizes evaluation function based on the classification of the Gaussian kernel function parameter intervals. The process of kernel function parameter optimization algorithm is designed. The results prove that - It has the very high practical value that Gaussian kernel function parameter optimization algorithm which is designed in this paper. The kernel function parameters $\lambda = 0.6$; comparatively analyzed Support vector machine classification results when $\lambda = 0.1, 0.2, \ldots, 0.9$; Verify the superiority of the parameter optimization algorithm.

Keywords: Support vector machine · Gaussian kernel function · Hilbert space · Classification interval · Parameter optimization

1 Introduction

Support vector machine (SVM) is a kind of supervised Machine learning method developed by the AT&T bell laboratories Vapnik based on structural risk minimization [1] and statistical learning theory [2]. The method is based on Maximum classification hyperplane interval linear separable problem [3]. Through the kernel function will develop linearly separable problem in nonlinear separable problem [4]. Kernel function is essentially a mapping function which can be lower dimensional linear score according to the mapped to high-dimensional feature space. Then, using the principle of the classification hyperplane interval maximization to solve classification [5]. Therefore, it is necessary for investigations of the kernel function. The model selection and the choice of parameters of kernel function directly affect the SVM learning effect. This paper mainly studies the kernel function of support vector machine (SVM) for the

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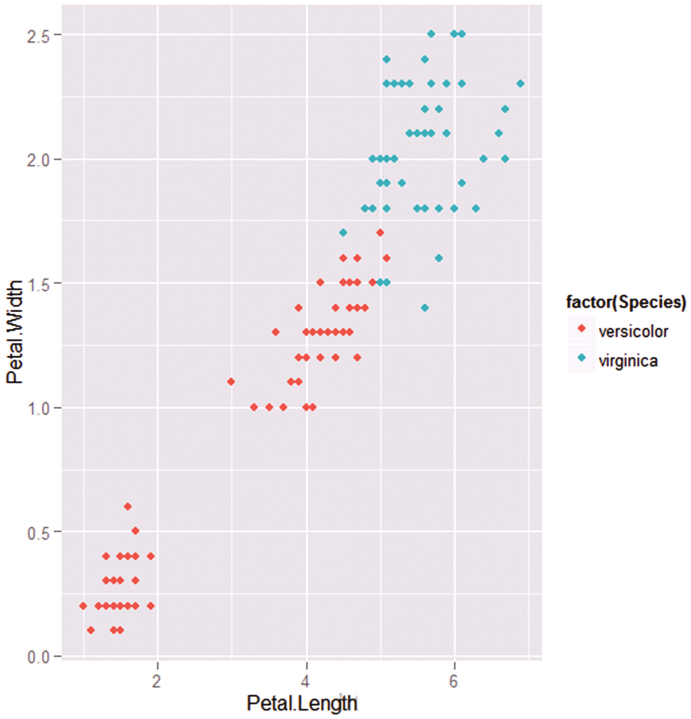

Fig. 1. SVM schematic

Gaussian kernel function (see Fig. 1). A lot of people have made efforts for this kind of kernel function is selected to study [6–9]. The scholar's research for Gaussian kernel function for support vector machines, most of them gives a new its application. And not the design algorithm for classification of kernel function parameter optimization. In this paper, on the basis of summarizing the predecessors' research results, set the criterion according to the distribution characteristics of the data is belong to the Gaussian distribution. In addition, design the separability measure data standard based on the Hilbert space distance. And design the iterative algorithm for the Gaussian kernel function parameter optimization in order to provide guidance for a reasonable application of Gaussian kernel functions in support vector machine (SVM) classification.

2 Paper Preparation

Mercer condition [10]: for any symmetric function $K(x_i, x_j)$, the necessary and sufficient condition for the inner product computation in a feature space, for arbitrary $\varphi(x) \neq 0$ and $\int \varphi^2(x)dx < \infty$, (1) was established:

$$\iint K(x, x')\varphi(x')dxdx' \geq 0 \tag{1}$$

By such as shown in the formula (2) support vector machine function, shows that the SVM through the inner product kernel function the original low dimensional space transform to high dimensional space, and classification of SVM discriminant is only related to the test samples and training samples, the support vectors.

$$f(x) = \mathrm{sgn}(w^* \bullet x + b) = \mathrm{sgn}\left(\sum_{i=1}^{n} \alpha_i^* y_i K(x_i \bullet x) + b^*\right) \tag{2}$$

SVM classification function is a set of linear combinations of nonlinear functions with support vectors as parameters. The SVM classification function is only related to the number of SVM, but has nothing to do with the dimension of the space. As a result, even though the dimension of the change space is increasing, it is not too much time complexity to find the optimal classification function. The working principle of SVM to deal with the nonlinear problem is shown in Fig. 2. Frequently used kernel function, including [11]: linear kernel function, polynomial function, radial basis kernel function, sigmoid function and Gaussian kernel function. This paper focuses on the study of Gauss kernel function.

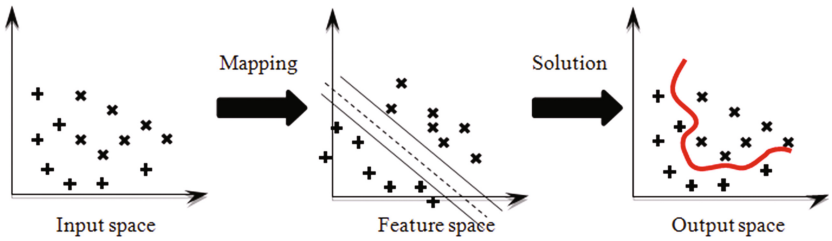

Fig. 2. SVM deals with nonlinear problems

3 SVM Kernel Function Parameter Selection Based on Gauss Distribution

3.1 Identification of Sample Data Distribution Characteristics

In this paper, it is helpful to improve the generalization ability of SVM if the kernel function is the Gauss kernel, and if the distribution of the data set is in agreement with the Gauss distribution. However, the distribution characteristics of the sample data are mostly unknown. If the distribution characteristics of some algorithms can be constructed to approximate the distribution characteristics of the sample data sets, then it is helpful to optimize the selection of SVM kernel function. Generalized Gaussian distribution (GGD) is a class to Gaussian distribution and Laplacian distribution as a special case, to function and uniform distribution is a limiting form of symmetric distribution, in many areas have wide application [10]. GGD probability density function (GGDPDF) see formula (3):

$$f(\mu;\alpha,\beta) = \left[\alpha/\left(2\beta\cdot\Gamma\left(\alpha^{-1}\right)\right)\right]\exp\left\{-[\mu/\beta]^T\right\} \quad (\alpha>0,\beta>0) \tag{3}$$

Type (3): α for the shape parameter, β for the scale parameter, $\Gamma(x) = \int_0^{+\infty} e^{-t}t^{x-1}dt$ for the Gamma Γ function.

Given a set of training samples $S = \{(x_1, y_1), \cdots, (x_l, y_l)\}$, determine whether the Gauss distribution of the steps are as follows:

STEP1. In the plane, take $m = k$, the real axis is divided into $k + 1$ intervals.

STEP2. Considered α, β as an unknown parameter, then the statistic is $V' = \sum_{i=1}^{m+1}\left[\left(v_i - \hat{l}p_i'\right)^2/\left(\hat{l}p_i'\right)\right]$, v_i which indicates the number of ($i = 1, 2, \cdots, m + 1$) random samples fall into the i segment, p_i' the probability of falling into the i segment, l for the total number of random samples.

STEP3. Firstly, using the maximum likelihood estimation method to get the estimated value of $\hat{\alpha}, \hat{\beta}$, p_i' of the resulting estimate is $\hat{p}_i'$, and then calculate the statistics is V'. If the 1 approximation is subject to a distribution of Sect. 3.2,

STEP4. If the V' distribution of $m - 2$ is the approximate obedience i^2, then the training samples are subject to GGD, on the contrary, the data to be measured is not subject to GGD.

3.2 SVM Kernel Function Parameter Selection Based on Gauss Distribution

The Kernel function of the essence is the low dimensional space of data is mapped to a high dimensional space, so that in high dimensional space can be divided into. Therefore, parameter selection of kernel function eventually, expect is $\Phi(x)$ sample by mapping from X the feature space to high dimensional feature space H through, with better separability. This paper from the geometric distance measure of the separability of the data. Then we can get the optimal, select the Hilbert space of square (4) as a measure of the separability of the data, I hope the distance between samples of the same category as small as possible, and different types of sample distance as large as possible. Mathematical formal representation, as shown in the formula (5).

$$\left\|\Phi(x_i) - \Phi\left(x_j\right)\right\|^2 = 2 - 2K\left(x_i, x_j\right) \tag{4}$$

$$\begin{cases} \min\left\|\Phi(x_i) - \Phi\left(x_j\right)\right\|^2, y_i y_j = +1 \\ \max\left\|\Phi(x_i) - \Phi\left(x_j\right)\right\|^2, y_i y_j = -1 \end{cases} \tag{5}$$

Combined (4) and (5), defined evaluation functions $L(\lambda)$ are shown in the formula (6):

$$L(\lambda) = \sum_{i=1}^{m}\sum_{j=1}^{i-1} K\left(x_i, x_j\right) * \left(y_i y_j\right) \tag{6}$$

In order to satisfy (9) the separability measure only needs to solve the maximum value of the type (10). Proposed a conformal transformation method, and the optimization of nuclear parameters is divided into two steps: the training of SVM and the modification of kernel functions. In the kernel function in the correction phase, the use of training in the previous step to obtain the initial parameters of the kernel, with data dependent method of kernel function secures transformation. Finally, we get an optimal result. In this paper, the SVM kernel parameter selection method based on Gauss distribution is given:

STEP1. Uses 3.1 data set distribution characteristics to determine the method to determine whether it is similar to Gauss distribution, if the data distribution in line with the Gauss distribution, then get the shape parameters α;

STEP2. Uses the Gauss nuclear SVM training data set, where the competition uses the Gauss nuclear SVM training data set, where the competition is $\lambda = \alpha$;

STEP3. Iteration to optimize the nuclear parameters of λ, take $\lambda = \frac{\lambda}{n}$ until the SVM effect is the best.

4 Empirical Analysis

In this paper, we study the example data as shown in Table 1:

Table 1. Two classification problem data list

No.	Input	Output	No.	Input	Output
1	5,4.5	True	6	1,2	False
2	3,7	True	7	3,5	False
3	6,6	True	8	7,3	False
4	4,6	True	9	3,4	False
5	5,6.5	True	10	6,2.7	False
/	/	/	11	4,3	False
/	/	/	12	2,7	False

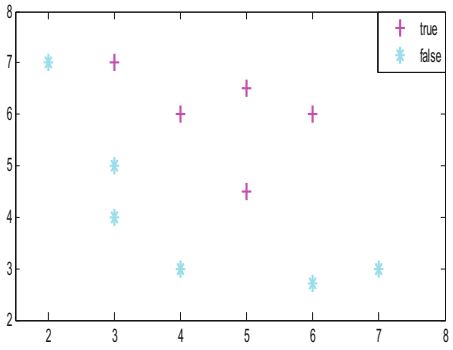

Fig. 3. The distribution of each point

The classification of the sample data set is the input data is divided into two categories, true or false. According to the different categories of original data, the drawing in a coordinate system, the distribution of each point is shown in Fig. 3. Using the sample data set in Table 1, call Gaussian kernel function of support vector machine classifier. Using the kernel function parameter optimization method from Sect. 3.2, come to a conclusion: when $\lambda = 0.6$, the SVM classification effect is better. The SVM classification result is shown in Fig. 3.

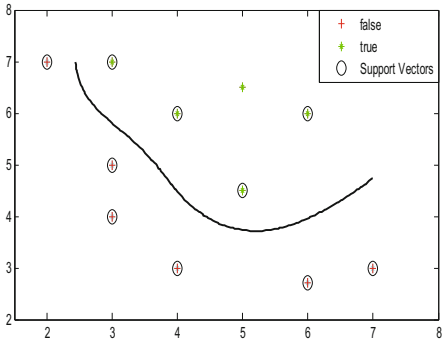

Fig. 4. SVM training results when λ = 0.6

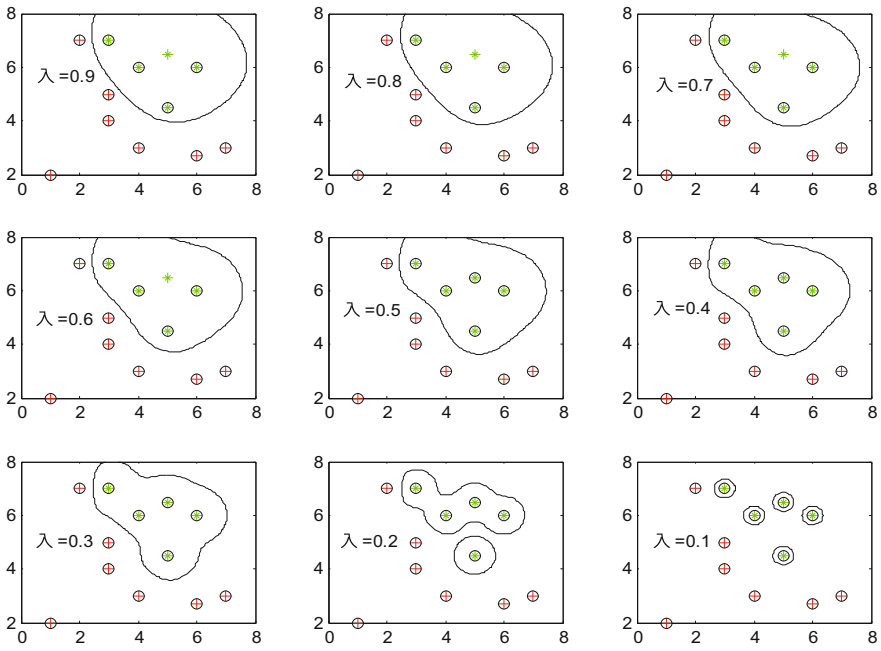

Fig. 5. Support vector machine training results when λ = 0.1, 0.2,…,0.9

When selecting parameters $\lambda = 0.9, 0.8, \cdots, 0.1$, Support vector machine (SVM) results as shown in Fig. 4:

Through comparing the effectiveness of the SVM classification in Fig. 5, may safely draw the conclusion that the parameter optimization results $\lambda = 0.6$, classification is also the best effect. Therefore, the parameters of the Gaussian kernel function optimization method designed in this article have strong advantages.

5 Conclusion

Support vector machine needs to choose kernel function according to data distribution characteristics, which is used for data classification. Need a discriminant for the distribution of sample data at the beginning of the Gaussian kernel function parameter optimization. Gaussian discriminant steps are given in this paper, design the evaluation function based on maximum interval. And the implementation process is designed. The empirical results show that: Gaussian kernel function parameter optimization algorithm designed in this article is feasible and the effect is remarkable.

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TSP Problem Based on Artificial Ant Colony Algorithm

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Abstract. An Artificial ant colony algorithm is a swarm intelligence optimization algorithm is advanced and it is widely used in many fields. In this paper, the algorithm applied to the TSP problem solving, to construct the model of an artificial ant colony system, was designed to solve the model algorithm. With 31 capital cities of the latitude and longitude data as a sample, using MATLAB software empirical the application effect of artificial ant colony algorithm in solving the traveling salesman problem (TSP), and verified the superiority of the algorithm through way of seven kinds of algorithms are compared. The results show that the application of an artificial ant colony algorithm in solving TSP is feasible, and obtains the traversal of 31 provincial capital cities of the shortest distance 38884 km and the shortest path; in the operation time and optimal solution quality, artificial ant colony algorithm than the others algorithms perform a certain superiority.

Keywords: Traveling salesman problem · Artificial ant colony · Pheromone update · Optimal solution · Shortest path

1 Introduction

1.1 Background

The traveling salesman problem is a typical NP-complete problem [1, 2] in combinatorial optimization problem, which is the abstract form of complex engineering optimization problems in many fields. A brief description of the problem is as below: with n cities, a traveling salesman from a city after the remaining $n-1$ cities, and finally back to the starting city, he should how to choose the path the shortest route problem, namely for the traveling salesman problem (see Fig. 1).

There are many of the algorithm for solving the traveling salesman problem, boils down to divide into two categories: a class is traditional optimization algorithm [3], the other is the modern optimization algorithm [4]. In this paper, drawing on the basis of

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Fig. 1. The TSP shortest distance problem

previous studies, explores the artificial ant colony algorithm realization principle. The result shows that the algorithm is solving the TSP problem in strong applicability, in order to verify the feasibility of the algorithm, the effectiveness and superiority, the author uses MATLAB software empirical the artificial ant colony algorithm application and through the comparison algorithm of artificial ant colony algorithm evaluation (see Fig. 2).

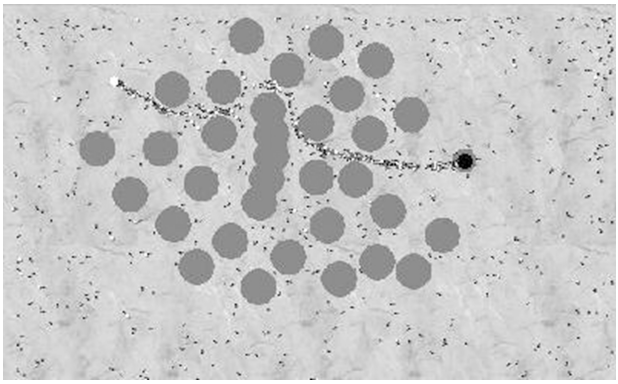

Fig. 2. A group of algorithm principle

1.2 Ant Colony Algorithm

An Ant colony algorithm is a random search algorithm. It is built on the research on the nature of the ant community collective went out in search of food behavior and simulate the whole process of real ant colonies together to find food, the ant colony search path of the shortest foraging process, information elements plays an important role and

path through pheromone of ant number will be more, after a period of time the positive feedback will enable more ants gathered to the relatively shortest path up [5].

As shown in Fig. 3, a food source and path diagram.

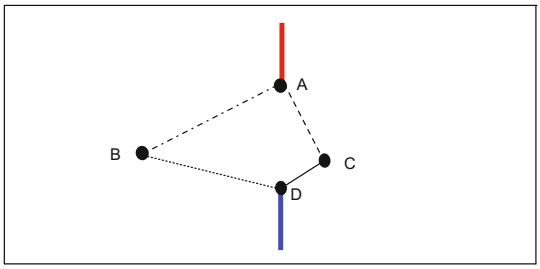

Fig. 3. Schematic diagram of ant colony foraging

In Fig. 3, Hypothesis in each Δt time interval is n ant from point a to point D, the ants are a unit speed crawling, ant can be in a unit length of path to leave the element information of a unit, and assume that at the moment of $t = 0$ path A-B-D and path A-C-D information for 0, so the ant from point a to point d path to choose the same probability, then ant path A-B-D. Also the only ants walk path A-C-D.

According to the above principle can be introduced, when ant colony has a number of foraging path situation and according to the changes in the concentration of pheromone, making more convergence ant colony to the relatively shortest path up [6], until all of the ants through the shortest path.

2 TSP Modeling Based on Ant Colony Algorithm

2.1 An Artificial Ant Colony System Model Based on TSP Problem

First of all, introduce the symbol shown in Table 1:

Table 1. Symbol description.

Symbol	Description
n	Number of cities
m	The number of ants in the ant colony
d_{ij}	The distance between i and j
$b_i(t)$	The number of ants in the city i at t moments
$\tau_{ij}(t)$	Trajectory intensity of t moment edge arc (i, j)
$\eta_{ij}(t)$	Visibility of t moment edge arc (i, j)

Table 1: $m = \sum_{i=1}^{n} b_i(t)$; $\tau_{ij}(t)$ indicates the amount of information on the *i, j* connection, and set $\tau_{ij}(0) = c$ (c as constant), $i, j = 1, 2, \cdots, n$, $i \neq j$; $\eta_{ij}(t)$ reflects the expectations of the city i transferred to the city of j [7, 8].

(1) The design of artificial ant colony search of TSP in the solution [9], and through a pheromone mediated communication with each other, in edge of each node and the nodes connected to the amount of pheromone search node on the basis of the test until you find the feasible solution of a TSP problem [10, 11].
(2) At the time of the t artificial ant k from position i to position j of the transition probability $p_{ij}^{k}(t)$, as shown in the Formula (1):

At type (1) parameters: $\alpha \geq 0$, $\beta \geq 0$ respectively indicates the relative importance of the track and the relative importance of visibility, respectively, which reflects the information and the role of the heuristic factor in the ant selection; s represents a set of feasible points, s said the feasible point set, that is, the next step in the city of ants k allowed to choose [12–15].

$$p_{ij}^{k}(t) = \begin{cases} \dfrac{\tau_{ij}^{\alpha}(t)\eta_{ij}^{\beta}(t)}{\sum_{v \in S} \tau_{iv}^{\alpha}(t)\eta_{iv}^{\beta}(t)} & j \in S \\ 0 & j \notin S \end{cases} \tag{1}$$

(3) When the individual workers in accordance with the m type (1) to find a feasible solution, the amount of information on each side of the type (2) modification. That is to adjust the amount of information to track the intensity of the update equation.

$$\tau_{ij}(t+1) = \rho\tau_{ij}(t) + \Delta\tau_{ij}, \quad \rho \in (0,1), \quad \Delta\tau_{ij} = \sum_{k=1}^{m} \Delta\tau_{ij}^{k} \tag{2}$$

Formula (2): $\Delta\tau_{ij}^{k}$ represents the amount of information that is left on the path (i, j) in the first loop of the k ant; $\Delta\tau_{ij}$ represents the increment of the amount of information on the loop path (i, j); The parameter ρ indicates the persistence of the trajectory; $1 - \rho$ indicates the degree of the degree of attenuation, and reflects the degree of the information.

3 Algorithm Design

In algorithm design, the meaning of STEP1-STEP5 is as follows:

STEP1. Define the number of iteration steps 0 to NC, initialization of each τ_{ij} and $\Delta\tau_{ij}$; the m ants are placed on the vertices of n.
STEP2. The initial starting point of each ant is placed in the current solution set, the $k(k = 1, 2, \cdots, m)$ of each ant is transferred to the next vertex j by the probability p_{ij}^{k}, and the vertex j is placed in the current solution set.
STEP3. Calculate the objective function value of each ant $z_k(k = 1, \cdots, m)$, record the current optimal solution.

STEP4. Modify the track strength according to the update equation.
STEP5. NC ← NC + 1, if NC is less than a predetermined number of iterations and no degradation, then switch to STEP2.

If in order to simplify the calculation, increase the ability to deal with the larger scale of the TSP problem, you can change the Formula (2) to the Formula (3):

$$\tau_{ij}(t+1) = \rho\tau_{ij}(t) + (1-\rho)\Delta\tau_{ij}, \rho \in (0,1) \tag{3}$$

Among them:

$$\Delta\tau_{ij}^{k} = \begin{cases} \frac{1}{d_{ij}}, & (i,j) \in BE \\ 0, & \text{otherwise} \end{cases}$$

4 Algorithm Demonstration

In this paper, the TSP problem of 31 provincial capital cities in China is studied. Collection of the original data for the capital city of latitude and longitude coordinates, coordinate format, such as Beijing (E116 degrees 28′, N39 degrees 54′) style, the actual distance between two points can be calculated using the Formula (4):

$$D_{ij} = 2\arcsin\sqrt{\sin^2\frac{\alpha}{2} + \cos(\text{Lat\_}i) \times \cos(\text{Lat\_}j) \times \sin^2\frac{\beta}{2}} \times 6378.137 \tag{4}$$

Using Matlab software, the calculation of the distance between the 31 capital cities of the matrix, the results of some of the results shown in Table 2.

Table 2. Partial distance data

Element	Beijing	Tianjin	Shanghai	Chongqing	…	Haikou
Beijing	0	125	1239	3026	…	2775
Tianjin	125	0	1150	1954	…	2792
Shanghai	1239	1150	0	1945	…	2134
Chongqing	3006	1954	1945	0	…	1467
⋮	⋮	⋮	⋮	⋮	…	⋮
Haikou	2775	2792	2134	1467	…	0

Using the artificial ant colony algorithm, looking for only once after 31 provincial capital of each city and return to the starting point of the shortest path, algorithm initialization parameters as shown in Table 3. The results are shown in Fig. 4.

The horizontal axis in Fig. 4 said the number of iterations and the vertical axis represents distance, shows the average traversal distance after each iteration and the shortest traversal distance, after 185 iterations, it is concluded that the shortest distance 38884 km, and concluded that the shortest distance path traversal.

Table 3. Initialization parameter setting

Parameter description	Value
Ant number	50
Pheromone important degree factor	1
The important degree factor of the heuristic function	5
Pheromone volatile factor	0.1
Constant coefficient	1
Initial value of iteration	1
Maximum number of iterations	200

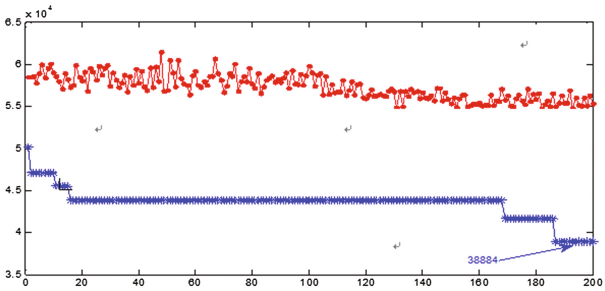

Fig. 4. Results of TSP problem solving based on ant colony algorithm

From Table 3, we can see that the artificial ant colony algorithm is designed in this paper, which shows a good performance in solving the TSP problem.

5 The References Section

The Artificial ant colony algorithm is a swarm intelligence, optimization algorithm is advanced, its biggest advantage is a positive feedback mechanism, that is, the information of renewal process and the algorithm of the applicable conditions: required to solve the problems are diagrammed. To define a positive feedback process; has since inspired features; can build up restraint mechanism. The TSP problem, just fit with it, the empirical results show that the artificial ant colony algorithm to solve the TSP problem is feasible, the results show that the algorithm has a strong advantage of artificial ant colony algorithm.

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Intelligent Security and Privacy

A Secure Pairing-Free Certificate-Less Authenticated Key Agreement Protocol

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Abstract. Pairing-free certificate-less two-party authenticated key agreement (CT-AKA) protocol is computation-efficient, easily manageable, and less key escrow dependent compared to traditional pairing-based identity-based protocol. In this paper, we propose four types of attacks on CT-AKA, present a pairing-free CT-AKA protocol and analyze its security in Lippold model. Compared with relevant CT-AKA protocols, our protocol is more efficient, secure and practical to apply.

Keywords: Certificate-less cryptography · Pairing-free · Authenticated key agreement

1 Introduction

Certificate-less public key cryptography (CL-PKC) introduced by Al-Riyami and Paterson [1] is a variant of identity based cryptography (IBC) [2] that limits the key escrow capabilities of the key generation center (KGC), which is inherent in identity-based cryptography(IBC) Two-party Authenticated key agreement (AKA) protocol is a mechanism that not only allow users to establish a session key known only to intended participants, but also ensure the authenticity of entities. The certificate-less public cryptography is constructed within the framework of IBC, thus many certificate-less authenticated key agreement is based on bilinear pairings or somewhat inefficient IBC scheme. The experiments shown that the pairing computation costs much more than scalar multiplication over the elliptic curve group, hence, many pairing-free certificate-less two-party authenticated key agreement (CT-AKA) protocols are proposed [3–6].

A certificate-less two-party authenticated protocol consists of two phases: setup parameters and message exchange, which are denoted as phase 1 and phase 2 respectively. Phase 1 consists of five probabilistic polynomial-time algorithms, i.e. *Setup*, *Partial-Private-Key-Extract*, *Set-Secret-Value*, *Set-Private-Key* and *Set-Public-Key*. Detailed explanations of these algorithms can be referred to [7–10]. In phase 2, two honest participants exchange messages by protocol specification. After a successful protocol run, these two participants will have the same session key. In the rest of this paper, we will describe the certificate-less by the above-mentioned algorithms.

The paper is constructed as follows. In Sect. 2, we propose four types of attack on CT-AKA protocol, namely known history secret values attack, impersonation attack,

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ephemeral key compromise attack and public-key-replacement attack, and review many known up-to-date protocols. The result shows that many protocols are susceptible to these attacks. In Sects. 3 and 4, we propose our pairing-free CT-AKA protocol and analysis its security. We compare our protocol with existing protocols in efficiency and security in Sect. 5. Finally, we draw some conclusions in Sect. 6.

2 Analysis of Pairing-Free CT-AKA Protocols

In this section, we will show classic attacks applied to CT-AKA protocols, especially the pairing-free ones and analyses respective reasons. To describe protocols uniformly in our analysis, we define some notations in Table 1.

Table 1. Protocol notations

Notation	Explanation
k	Security parameter
p	A large prime
q	A large prime
G	A cyclic elliptic curve cryptography subgroup of order q
P	Generator of G
ID_i	The identity of entity i
s_i	The partial private key of entity i, $s_i \in_R Z_q^*$
R_i	The partial public key of entity i
x_i	The secret value of entity i, $x_i \in_R Z_q^*$
X_i	The long-term public key of entity I, $X_i = x_iP$
e_i	The ephemeral private key of entity i
E_i	The ephemeral public key of entity I, $E_i = e_iP$.
s	The master secret key(MSK) of KGC, $s \in_R Z_q^*$
P_{pub}	The system public key, $P_{pub} = sP$
H_1, H_2, H_3	Cryptographically secure hash functions

The paper is based on a cyclic elliptic curve cryptography group. A user i with identity ID_i holds private key (s_i, x_i) and public key (R_i, X_i), where x_i is selected by i randomly, and $X_i = x_iP$, while s_i and R_i are computed by KGC in *Partial-Private-Key-Extract* algorithm.

2.1 Known History Secret Values Attack

In some protocols [11, 12], the relationships of both participants' secret values in session key constructions are loose coupling. It is difficult for adversary to obtain private keys in most cases, but, in some poor implementations, it is relative easy to read the intermediate secret values in memory. This may lead to a type of attack; we call it *known history secret values attack*.

Take [13] for example. System parameters and user's key pair can be referred to Table 1. KGC selects two cryptographic secure hash functions $H_1 : \{0,1\}^* \times G^2 \rightarrow Z_q^*$ and $H_2 : \{0,1\}^* \times G^3 \rightarrow Z_q^*$. The procedure of KGC generates partial key s_i and R_i for user i with identity ID_i is: KGC randomly selects r_i from Z_q^*, computes $R_i = r_i P$, $Q_i = H_1(ID_i, R_i, X_i)$ and $s_i = r_i + sQ_i$. For more protocol details, refer to [14–17].

Key Agreement: Two entities A and B exchange messages as follows to establish a session key. The message flow is shown in Fig. 1.

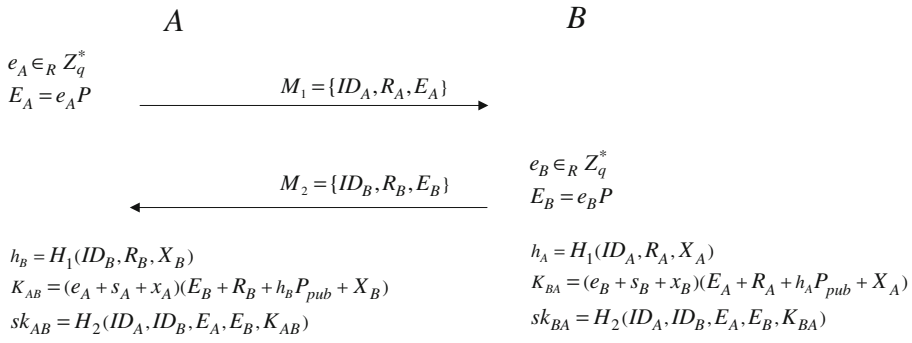

Fig. 1. Message flow of Farouk et al.'s protocol

If an adversary M compromises the sum of A's secret value $(e_A + x_A + s_A)$ of a history session (M need not know A's individual private value), eavesdrops and records all transcripts of the session. We denote the record messages by M_1 and M_2, and then M can mount replay attack as follows.

(1) M sends $M_1 = (ID_A, R_A, E_A)$ to B by his records;

(2) Upon receiving M_1, B randomly chooses $e_B^{'} \in Z_q^*$, computes $E_B^{'} = e_B^{'} P$, $K_{BA}^{'} = (e_B^{'} + x_B + s_B)(E_A + X_A + R_A + H_1(ID_A, R_A, X_A)P_{pub})$ and $sk_{BA}^{'} = H_2(ID_A, ID_B, E_A, E_B, K_{BA}^{'})$ and sends $M_2^{'} = (ID_B, R_B, E_B^{'})$ to A;

(3) M intercepts M_2, and calculates the shared value $K_{AB}^{'} = (e_A + x_A + s_A)(E_B^{'} + X_B + R_B + H_1(ID_B, R_B, X_B)P_{pub})$ and the session key $sk_{AB}^{'} = H_2(ID_A || ID_B || E_A || E_B || K_{AB}^{'})$. Obviously, $sk_{AB}^{'} = sk_{BA}^{'}$. Entity B believes that he and A engage in a protocol run, but actually his partner is M.

The similar attack can be applied to [18].

2.2 Impersonation Attack

Because of the loose coupling in session key construction, we will show that a protocol which is susceptible to known history secret value attack explained in Sect. 2.1 is also vulnerable to impersonation attack, which means the protocol is not secure in the eCK model. We take protocols in [19] for example, the same attack can be applied to [20].

Brief description of the protocol can be referred to Sect. 2.1. We will show that Farouk et al.'s protocol is susceptible to impersonation attack.

1. A randomly chooses $e_A \in Z_q^*$, and computes $E_A = e_A P$, then sends $M_A = \{ID_A, R_A, E_A\}$ to B.
2. E intercepts message M_A, randomly chooses $e_B \in Z_q^*$ and computes $E_B^{'} = -H_1(ID_B, R_B, X_B)P_{pub} - R_B - X_B + e_B P$ and sends $M_B^{'} = \{ID_B, R_B, E_B^{'}\}$ to A. E can computes the session key as follows: $sk_{EA} = H_2(ID_A, ID_B, E_A, E_B^{'}, K_{EA})$, where $K_{EA} = e_B(E_A + X_A + R_A + h_A P_{pub})$.
   Since the adversary E can obtain e_B, he can compute K_{EA} by random value e_B which is selected by E and other public values.
3. Upon receiving message $M_B^{'}$, entity A computes the shared session key as follows.

$$sk_{AB} = H_2(ID_A, ID_B, E_A, E_B^{'}, K_{AB}),$$

where $K_{AB} = (e_A + s_A + x_A)(E_B^{'} + R_B + H_1(ID_B, R_B, X_B)P_{pub} + X_B)$.

We can see that $K_{AB} = (e_A + s_A + x_A)e_B P = K_{EA}$, thus $sk_{EA} = sk_{AB}$, which means that the Farouk et al.'s protocol is susceptible to impersonation attack.

2.3 Ephemeral Key Compromise Attack

Traditional key compromise attack means that when the long-term key of an entity A is compromised, the adversary may be able to masquerade not only as A but also to A as another party B. In ephemeral key compromise attack, the adversary obtains only the ephemeral private key rather than the long-term of entity A to mount the impersonation attack. We take protocol in [21] for example.

System parameters and user's key pair can be referred to Table 1. KGC selects three cryptographic secure hash functions $H_1 : \{0,1\}^* \times G \to Z_q^*$, $H_2 : \{0,1\}^* \times G^3 \to Z_q^*$ and $H_3 : \{0,1\}^* \times \{0,1\}^* \times G^4 \to \{0,1\}^k$. The procedure of KGC generates partial key s_i and R_i for user i with identity ID_i is: KGC randomly selects r_i from Z_q^*, computes $R_i = r_i P$, $Q_i = H_1(ID_i, R_i)$ and $s_i = r_i + sQ_i$. For more protocol details, refer to [22].

Key Agreement: Two entities A and B exchange messages as follows to establish a session key. The message flow is shown in Fig. 2.

If the adversary E can obtain party A's ephemeral private key e_A, the he can mount the impersonation attack as follows.

1. A randomly chooses $e_A \in Z_q^*$, and computes $E_A = e_A P$, then sends $M_A = \{ID_A, R_A, E_A\}$ to B.
2. E intercepts message M_A, randomly chooses $e_B \in Z_q^*$ and computes $E_B^{'} = -H_2(ID_B, R_B, X_B, P_{pub})X_B - R_B - H_1(ID_B, R_B)P_{pub} + e_B P$ and sends $M_B^{'} = \{ID_B, R_B, E_B^{'}\}$ to A. E can computes the session key as follows:

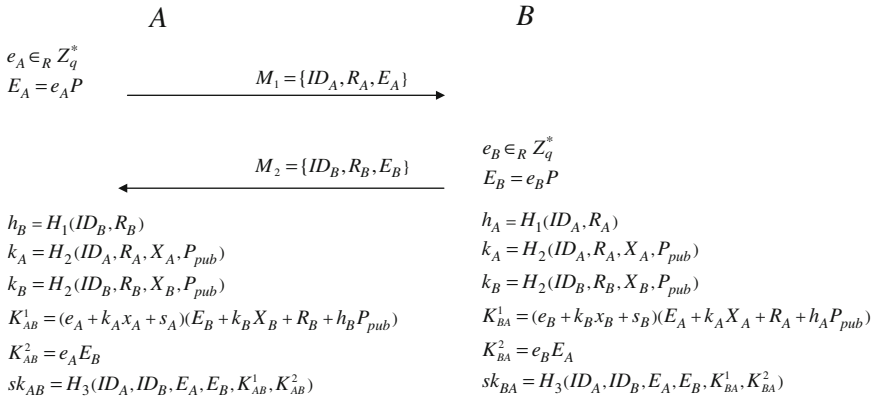

Fig. 2. Message flow of Tu et al.'s protocol

$$sk_{EA} = H_3(ID_A, ID_B, E_A, E_B', K_{EA}^1, K_{EA}^2),$$

where $K_{EA}^1 = e_B(E_A + k_A X_A + R_A + h_A P_{pub})$, $K_{EA}^2 = e_A E_B'$

Since the adversary E can obtain e_A, he can compute K_{EA}^2. In addition, E can also compute K_{EA}^1 by random value e_B which is selected by E and public values.

3. Upon receiving message M_B', entity A computes the shared session key as follows.

$$sk_{AB} = H_3(ID_A, ID_B, E_A, E_B', K_{AB}^1, K_{AB}^2),$$

where $K_{AB}^1 = (e_A + k_A x_A + s_A)(E_B' + k_B X_B + R_B + h_B P_{pub})$, $K_{EA}^2 = e_A E_B'$.

We can see that

$$K_{AB}^1 = (e_A + k_A x_A + s_A)(E_B' + k_B X_B + R_B + h_B P_{pub}) = (e_A + k_A x_A + s_A) e_B P = K_{EA}^1$$

and $K_{AB}^2 = e_A E_B' = K_{EA}^2$, thus $sk_{AB} = sk_{EA}$.

It means that the adversary E and entity A established the same session key. The adversary E has successfully cheated entity A to believe that he has shared secret session key with party B. However, party B does not engage in this session completely. It means that the Tu et al.'s protocol is not secure against the ephemeral key compromise attack.

2.4 Public-Key-Replacement Attack

Because of the lack of verification of public key with certificate-less mechanism, *public-key-replacement attacks* are the most common and powerful attacks. It's also called Type I attack. There are many deliberate constructions of public key replacement attacks [23]. In fact, the purpose of a certificate-less cryptography is to solve the key

escrow problem of identity-based public key cryptography (ID-PKC) by generating public keys by two entities: the KGC and the key owner. Only under the condition that the protocol is still secure when not all the private keys of both participants are compromised, we consider the protocol is a secure one. But from these ingenious attacks, we can find that the public key of a partial private key can be eliminated by new modified public key [18, 24–26], or the long-term public keys can be eliminated by modified ephemeral public key [25, 27].

2.5 Security in Lippold Model

Many researchers present their attacks to a previous protocol, and propose a new improvement protocol that is immune to these attacks [27], but some of these new protocols are still insecure under the Lippold security model. The Lippold model requires that an adversary may corrupt at most two out of three types of secrets per party involved in the test session. As mentioned in [3], for the protocol in [8], if the attacker compromise user A's ephemeral private key e_A and user B's ephemeral secret value e_B, then the attacker can compute the session key. We take protocol of [18] as an example to show that it is insecure in Lippold model.

For the protocol in [18], if the attacker compromise user A's partial private key s_A, user A's ephemeral private value e_A, user B's ephemeral private key e_A, user B's long-term secret value x_B, then the attacker can derive the session key too.

System parameters and user's key pair can be referred to Table 1. KGC selects two cryptographically secure hash functions $H_1 : \{0,1\}^* \times G \rightarrow Z_q^*$ and $H_2 : \{0,1\}^* \times \{0,1\}^* \times G^5 \rightarrow Z_q^*$. The procedure of KGC generates partial key s_i and R_i for user i with identity ID_i with identity ID_i is: KGC randomly selects r_i from Z_q^*, computes $R_i = r_iP$, $Q_i = H_1(ID_i, R_i)$ and $s_i = r_i + sQ_i$. For more protocol details, refer to [18].

Key Agreement: Two entities A and B exchange messages as follows to establish a session key. The message flow is shown in Fig. 3.

If the attacker learn user A's partial private key s_A, user A's ephemeral private value e_A, and user B's ephemeral private key e_A, user B's long-term secret value x_B by oracle queries, plus some public values, then the attacker can compute the shared secrets: $K_{AB}^1 = (e_A + s_A)(E_B + R_B + k_B P_{pub})$, $K_{BA}^2 = (e_B + x_B h_2)(E_A + h_1 X_A)$ and $K_{AB}^3 = e_A E_B$. Thus the attacker can derive the session key by $sk = H_2(ID_A, ID_B, E_A, E_B, K_{AB}^1, K_{BA}^2, K_{AB}^3)$.

2.6 Countermeasures

To defeat these attacks, many new improvements have been proposed. He [8] proposed that a user U call *Set-Secret-Value* first to get secret value x_u and public key X_U, then call *Partial-Private-Key-Extract* to generate private key by ID_U, R_U and P_U other than by ID_U and R_U. This improvement can resist public key replacement attacks. Tu [16], Cheng [18] and Tong [22] proposed to calculate the hash value of both participants' IDs and long-term/ephemeral keys in shared value constructions to secure its freshness

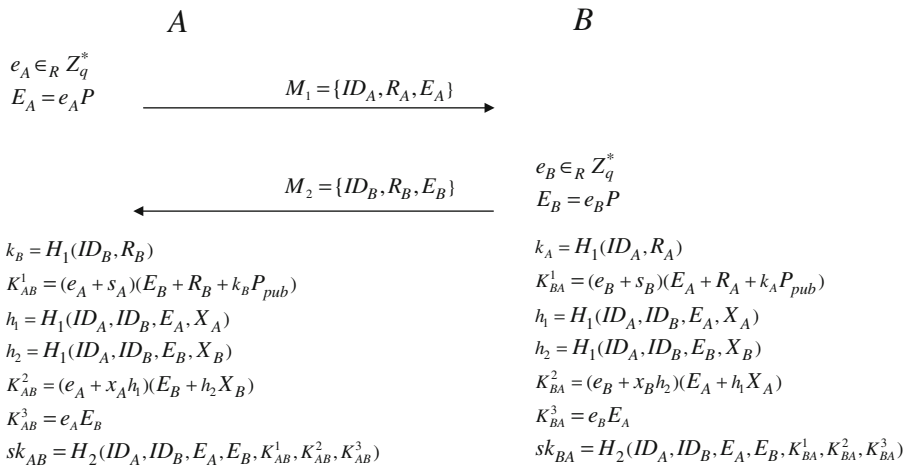

Fig. 3. Message flow of Cheng's protocol

and resist public key replacement respectively; Sun et al. [3] proposed to diversify the combination of private keys when calculating session key, and increased the number of shared values to six; The session key calculated in Sun et al.'s [18, 24] scheme consists of three shared values, and each of these values contains different combinations of both participants' secret values; Liu [14] and Zhu [15] proposed to integrate a signcrypt algorithm into key agreement protocol to guarantee freshness and resist public key replacement attacks. Many researchers propose an improvement protocol to prevent against some known attack [18, 28], but some of these new protocols are still insecure.

From the above schemes review, we can see that it's hard to design a secure CT-AKA protocol.

3 Our Pairing-Free CT-AKA Protocol

With the analysis of known attacks and advices of [19] and [20], we propose a pairing-free two-party certificate-less key agreement protocol to meet demands of security and efficiency. The protocol consists of six algorithms.

Setup. The input of this algorithm is a security parameter k, the output is a list of system parameter $params = (F_q, E, G, P, P_{pub}, H_1, H_2)$. The function is run by KGC as follows:

(1) Choose a k-bit prime p, and define an elliptic curve E over F_p;
(2) Choose a public point P of prime order q over E and generate a cyclic additive group G of order q by P.
(3) Randomly Choose a number $s \in_R Z_q^*$ as the master secret key, computes $P_{pub} = sP$ and set P_{pub} as the system public key;

(4) Choose two cryptographically secure hash functions $H_1 : \{0,1\}^* \times G \rightarrow Z_q^*$ and $H_2 : \{0,1\}^{*2} \times G^7 \rightarrow \{0,1\}^k$;
(5) Publish the system parameters $params = (F_q, E, G, P, P_{pub}, H_1, H_2)$ and keep the master secret key s secret.

Partial-Private-Key-Extract: Given a user i with identity $ID_i \in \{0,1\}^*$, KGC randomly chooses a number $r_i \in_R Z_q^*$, computes $R_i = r_iP$, $Q_i = H_1(ID_i, R_i)$ and $s_i = r_i + sQ_i$. Then KGC sends (s_i, R_i) to i via a safe channel. User i's partial private key and partial public key are s_i and R_i respectively. He can verify its correctness by checking whether $s_iP = R_i + H_1(ID_i, R_i)P_{pub}$ holds.

Set-Secret-Value: The user i randomly chooses $x_i \in_R Z_q^*$ and sets x_i as his secret value.

Set-Public-Key: The user i computes $X_i = x_iP$ and sets X_i as his public key.

Set-Private-Key: The user i sets the pair $sk_i = (x_i, s_i)$ as his private key.

Key-Agreement: Assume that a user A with identity ID_A has private key $sk_A = (x_A, s_A)$ and public key $pk_A = (X_A, R_A)$ wants to establish a session key with another user B whose identity is ID_B with private key $sk_B = (x_B, s_B)$ and public key $pk_B = (X_B, R_B)$. User A and B run the protocol as follows.

(1) A randomly chooses an ephemeral key $e_A \in Z_q^*$, computes $E_A = e_AP$ and sends $M_A = (ID_A, ID_B, R_A, E_A)$ to B;
(2) Upon receiving M_A, B randomly chooses an ephemeral key $e_B \in Z_q^*$, computes $E_B = e_BP$ and sends $M_B = (ID_B, ID_A, R_B, E_B, E_A)$ to A. Then B computes $SP_A = R_A + H_1(ID_A, R_A)P_{pub}$ and its session key $SK_{BA} = H_2(ID_A, ID_B, E_A, E_B, X_A, X_B, Z_B^1, Z_B^2, Z_B^3)$, where $Z_B^1 = (s_B + e_B)(SP_A + X_A) + x_BE_A$, $Z_B^2 = (x_B + s_B)(X_A + E_A) + e_BSP_A$ and $Z_B^3 = (x_B + e_B)(E_A + SP_A) + s_BX_A$;
(3) Upon receiving M_B, A computes $SP_B = R_B + H_1(ID_B, R_B)P_{pub}$ and its session key $SK_{AB} = H_2(ID_A, ID_B, E_A, E_B, X_A, X_B, Z_A^1, Z_A^2, Z_A^3)$, where $Z_A^1 = (x_A + s_A)(E_B + SP_B) + e_AX_B$, $Z_A^2 = (x_A + e_A)(X_B + SP_B) + s_AE_B$ and $Z_A^3 = (e_A + s_A)(X_B + E_B) + x_ASP_B$.

We can check the correctness that: $Z_A^1 = (x_Ae_B + x_As_B + s_Ae_B + s_As_B + e_Ax_B)P = Z_B^1$, $Z_A^2 = (x_Ax_B + x_As_B + e_Ax_B + e_As_B + s_Ae_B)P = Z_B^2$ and $Z_A^3 = (e_Ax_B + e_Ae_B + s_Ax_B + s_Ae_B + x_As_B)P = Z_B^3$. Thus user A and B share the same session key.

4 Security Analysis

4.1 Proof

The security proof of our protocol is similar to [3]. Under the GDH assumption [26, 28] over the elliptic curve group, if H_1 and H_2 are random oracles, then the proposed protocol described in Sect. 3 is a secure certificate-less authenticated key agreement

Table 2. Possible corrupt strategies

Strategy	1		2		3/4 (mirr.)		5/6 (mirr.)		7/8 (mirr.)		9	
Value at party p	I	J	I	J	I	J	I	J	I	J	I	J
Partial private key	C	C	C	C	C	C		C		C		
Secret value/public key			C/R	C/R		C/R	C/R		C/R	C/R	C/R	C/R
Ephemeral private key	C	C			C		C	C	C		C	C
Embedding in	$x_I x_J P$	$e_I e_J P$	$e_I x_J P$/ $e_J x_I P$	$e_I r_J P$/ $e_J r_I P$	$x_I r_J P$/ $x_J r_I P$	$r_I r_J P$						
Problem type	CDH	CDH	CDH	CDH	CDH	CDH	CDH	CDH	CDH	CDH	CDH	CDH

Where, C = corrupt, R = replace, mirr. = swap columns I and J

protocol in a model of [3]. We outline the proof here for simplicity. The model in [3] is a variant of the Lippold model [4], in which the active adversary may corrupt at most two out of three types of secrets per part in the test session. Thus, the adversary has nine corrupt strategies in Table 2.

In each strategy, we can prove that the adversary has only a negligible advantage win the game under GDH assumption. If a protocol is secure in the Lippold model, then it achieves implicit mutual key authentication and desirable security attributes, including ephemeral secret leakage resistance, weak perfect forward security, key compromise impersonation resistance, and so on [3]. Similar detailed proof can be referred to [3].

The participant's individual private keys are tight coupling in the formula of session keys, our protocol is immune to known history secret values attack and impersonation attack. From the three shared secret values constructions, we can see that it is hard to eliminate the combination of user's private values in any one.

4.2 Other Security Attributes

Beside the security attributes mentioned in [3], we will show that our protocol achieves the following security attributes.

(1) *Known key security*. This property means a disclosed session key does not affect the security of other session keys; even those sessions' participants remain the same. In each run of our protocol, both participants generate an ephemeral private key to compute the session key, this make each session derive a unique session key with great probability.

(2) KGC forward secrecy. This property implies that the KGC's master key should be unable to compute the session key knowing all publicly available information. Our protocol is secure under Lippold model, which means it is a strong type II secure key agreement scheme.

(3) Resistance to Unknown key-share resilience. This property can ensure that principals do not give away information to the wrong party or accept data as coming from the wrong party. In our protocol, the session key formula contains the identities of both participants and ephemeral public values; and it is hard to mount an ephemeral key compromise attack described in Sect. 2.3.
(4) No key-control. This property implies that no principal is able to choose or influence the value of the shared session key. Both participants' private keys are symmetric in the shared secret values and session key of our protocol, none of them can completely control the final value.

5 Comparison with Other Protocols

In section, we compare our protocol with several other pairing-free CT-AKA protocols by efficiency and security in Table 1. The notations are defined as follows.

T_{mul}: The time of executing a scalar multiplication of a elliptical curve point;

T_{hash}: The time of executing a hash operation.

From the Table 3, we can see that the protocols HPC-12 [8], TKKS-15 [16], FM-14 [11] are insecure under Lippold model, and the protocols SWZJ-13 [3], LX-10 [14], Cheng-12 [18] are secure but need more computation than our protocol. We can

Table 3. Comparisons

Protocol	Computation cost	Signcrypt	Security in eCK
HPC-12 [8]	$5T_{mul} + 2T_{hash}$	No	No
SWZJ-13 [3]	$8T_{mul} + 2T_{hash}$	No	Yes
TKKS-15 [16]	$5T_{mul} + 4T_{hash}$	No	No
FM-14 [11]	$3T_{mul} + 2T_{hash}$	No	No
LX-10 [14]	$7T_{mul} + 5T_{hash}$	Yes	Yes
Cheng-12 [18]	$5T_{mul} + 4T_{hash}$	No	Yes
Our protocol	$5T_{mul} + 2T_{hash}$	No	Yes

conclude that our protocol is secure and efficiency than other pairing-free CT-AKA protocols.

6 Conclusion

We proposed four practical CT-AKA attacks, analyzed security requirement in Lippold model and presented an Lippold-secure pairing-free certificate-less key agreement protocol. The analysis shows that our protocol is secure and efficient, and is more suitable for practical applications.

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An Attribute-Based Encryption Scheme with LSSS Key-Policy from Lattices

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Abstract. A new attribute-based encryption scheme (ABE) from lattices with Linear Secret Sharing Scheme (LSSS) key-policy is presented. In the new scheme, the key of an attribute under an access policy represented by LSSS is generated by the use of the sample-pre algorithm on lattices. Every attribute has its own authority, and the private key of each attribute under an access policy is produced by its own authority alone. The new scheme has the advantage of fine-grained access control, and also could support multi-authority attribute management, thus it facilitates the practical management of attribute encryption system. The security of the new scheme is proved in the selective-attribute attack model under learning with errors (LWE) assumption, and the security parameter selecting is discussed in detail.

Keywords: Attribute-based encryption · Key-policy · Linear secret sharing scheme · Lattices

1 Introduction

Attribute-based encryption (ABE) is an extension of public-key cryptography and identity-based encryption [1–5]. And it can be extended to the attribute signature [6, 7], attribute security protocols [8, 9] and other research field [10–12]. Compared with the traditional cryptography, ABE seems to have a more flexible logic relationship, as the attribute management could extend "one-to-one model" to "one-to-many model". And an encryption policy of ABE could support complex access structures, such as threshold, the Boolean expression and so on.

In 2005, Sahai et al., firstly introduced the notion of ABE at EUROCRYPT, as an extension of identity-based encryption, in which user credentials is described as sets of attribute and the predicate is described as a formula about these attributes. Subsequently, in 2006, Goyal et al., further clarified the notion of ABE. They proposed two complementary forms of ABE: Key-policy ABE (KP-ABE) and Ciphertext-policy ABE (CP-ABE) They developed a Key-policy ABE for fine-grained sharing of encrypted data. In their cryptosystem, ciphertexts is labeled with sets of attribute and private keys are associated with access structures that control which ciphertexts a user is able to decrypt. In 2007, Boneh et al., presented a CP-ABE, which could be secure

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against collusion attacks. Latterly, Waters presented a new scheme for CP-ABE under concrete and non-interactive cryptographic assumptions in the standard model. In order to describe more flexible ciphertext protection strategy, and express more complex logic relationships, the researchers proposed the access tree and some other complex access structure in the encryption scheme, and to achieve better results in literatures. However, the above encryption schemes are mainly based on bilinear pairing technology with the bilinear Diffie-Hellman assumption. The main drawbacks of these schemes are vulnerable to quantum attacks.

Currently, lattice-based cryptography is considered to be the most promising candidate for post-quantum cryptography, so far there is no viable quantum algorithm to solve difficulty lattice problems. Meanwhile, lattice-based cryptography has simply operation and provides higher security more than the traditional public-key cryptographic technology.

In 1996, Ajtai [13] firstly introduced the lattice problem in the field of cryptography applications, in which he discovered some connections between the worst-case complexity and average-case complexity of some lattice problems. Based on these results, Ajtai and Dwork [14] constructed a public-key cryptosystem, and its security could be proven using only the worst-case hardness of a certain version of SVP. Thereafter, until 2008, Gentry et al. [15].

Main motivation: In this paper, we will focus on Boyen's lattice-based ABE [16].

Our Contributions: An attribute-based encryption scheme with key-policy represented by LSSS from lattices is presented in this paper, where the private key of an attribute under an access policy is computed in a different method. In new scheme every attribute can have its own authority, and the private key of each attribute under an access policy is produced by only the attribute authority, the private key of an access policy is computed as a whole, that is, it needs all secret keys of the attributes which satisfy the access policy.

Organization: The rest of this paper is organized as follows. In Sect. 2 we give the algorithmic definition for the Key-Policy encryption scheme. In Sect. 3 we describe our new scheme. The correctness and security of our construction are given in Sect. 4. Finally, we conclude the paper in Sect. 5.

2 Preliminaries

2.1 Notation

By convention, let $\mathbb{Z}$ be the set of the integers, and let $\mathbb{R}$ be the set of real numbers. For any integer q, let $\mathbb{Z}_q^{n\times m}$ be the $n \times m$ matrices with entries in $\mathbb{Z}_q$. Let $[n]$ be the set of positive integers $\{1, 2, \ldots, n\}$, and $\Lambda \in \mathbb{R}^m$ be a m-dimensional lattice. Vectors are specified to be in column form and be denoted by bold lower-case letters, e.g. $\mathbf{x}$. The i-th element of vector $\mathbf{x}$ is denoted as x_i. Similarly, denote matrices as bold capital letters, e.g. $\mathbf{X}$, and the i-th vector by a matrix $\mathbf{X}$ is denoted as $\mathbf{x}_i$. The norm of a matrix $\mathbf{X}$ is defined as $\|\mathbf{X}\|_2$, the Gram-Schmidt orthogonal basis of $\mathbf{X}$ is denoted as $\tilde{\mathbf{X}}$.

2.2 Key-Policy Attribute Based Encryption

(1) Algorithms Definition

Here we give a new definition of the key-policy ABE, which is suitable for our purpose, and is based on the framework of Goyal et al.

A key-policy attribute-based encryption scheme consists of the following four PPT algorithms:

KP-ABE.Setup$(\lambda) \rightarrow (Pub,Msk)$: The system setup algorithm takes a security parameter λ as input. It outputs the public parameters *Pub* and the corresponding master key *Msk*.

KP-ABE.Extract$(Pub, \mathbf{B}_{\rho(i)}, (\mathbf{M}, \rho)) \rightarrow Key_{\rho(i)}$: The key extraction algorithm takes as input the public parameters *Pub*, the master key *Msk*, and an access policy $(\mathbf{M}, \rho)$, where *Pub* and $\mathbf{B}_{\rho(i)}$ is corresponding to the attribute $\rho(i)$ on the policy $(\mathbf{M}, \rho)$. It outputs decryption keys $Key_{\rho(i)}$ of each attribute $\rho(i)$ on the access policy $(\mathbf{M}, \rho)$.

KP-ABE.Encrypt$(Msg, Attrib, Pub) \rightarrow C_{tx}$: The encryption algorithm takes as input a message bit $Msg \in \{0,1\}$, the public parameters *Pub*, and a set of attributes *Attrib*. It outputs the ciphertext C_{tx}.

KP-ABE.Decrypt$(Pub, Key, C_{tx}) \rightarrow b$: The decryption algorithm takes as input the public parameters *Pub*, the decryption keys *Key*, and the ciphertext C_{tx}, where *Key* is a set of $Key_{\rho(i)}$ when the attribute $\rho(i)$ belonging to *Attrib* (by use to create C_{tx}). It outputs the bit b when the set of attribute *Attrib* satisfy the access policy $(\mathbf{M}, \rho)$. Otherwise, decryption fails.

Definition 1. A KP-ABE scheme is said to be correct, if all attribute subsets $Attrib^*$ satisfy access policy $(\mathbf{M}, \rho)$ (i.e. $Attrib^*$ is authorized), it is true for $Decrypt(Pub, Key, C_{tx}) = Msg$, when any pair (Pub, Msk) is generated by $Setup(\lambda)$, and any the decryption key $Key_{\rho(i)}$ is outputted from $Extract(Pub, \mathbf{B}_{\rho(i)}, (\mathbf{M}, \rho))$, and any ciphertext C_{tx} is outputted from $Encrypt(Msg, Attrib, Pub)$.

(2) Selective Security Definition

We define the selective-security model for key-policy ABE systems as given by Boyen in the following game between an adversary and a challenger.

Target: The adversary declares the attributes $Attrib^*$, which will wish to be challenged.

Setup: The challenger obtains the public parameters *Pub* and corresponding master key *Msk* by invoking the system setup algorithm, and gives the public parameters *Pub* to the adversary.

Queries: The adversary issues adaptive private keys *Key* queries by submitting attribute i to the challenger, where i is an attribute on its policy $(\mathbf{M}, \rho)$, as long as $Attrib^*$ does not satisfy the policy $(\mathbf{M}, \rho)$.

Challenge: The adversary gives a sign in readiness for accepting a challenge, and specify a message *Msg* to encrypt. The challenger encrypts the message *Msg* for the challenge attributes $Attrib^*$. And then the challenger flips a random coin $r = \{0,1\}$. If $r = 1$, the ciphertext is send to the adversary. Otherwise, if $r = 0$, a random element of the ciphertext space is send to the adversary.

Queries: The adversary may do additional key queries, this is a continuation of the earlier query phase.

Guess: The adversary must submit a guess r' of r. The adversary's advantage in this game is defined as $|\Pr[r' = r] - \frac{1}{2}|$.

Definition 2. *A key-policy attribute-based encryption system is selectively secure if all PPT adversaries have at most a negligible advantage in this security game, where the adversary's advantage is defined as* $Adv = |\Pr[r' = r] - \frac{1}{2}|$.

3 A New Attribute-Based Encryption from Lattice

In this section, we construct a new key-policy ABE scheme from the lattice, the key-extract algorithm will generate the corresponding key for every attribute under an access policy represented by LSSS, and each of the attribute in the universe attribute set $\mathcal{U}$ is managed by its own attribute authority, the attribute authority is responsible for key generating of an attribute. And we suppose that each attribute u_k ($u_k \in \mathcal{U}$) has its own attribute authority, denoted as local authority $Auth_k$, and there is a central authority to generate some public parameters.

A new lattice-based key-policy ABE scheme consists of the following four algorithms:

- ***KP-ABE.Setup***$(\lambda) \rightarrow (pub, Msk)$: This algorithm takes a security parameter λ as input, do:

1. The central authority selects three public parameters n, m and q, and publishes them, where $n > \Omega(\lambda)$ be a security dimension, $m > 2n \log q$ be a lattice base dimension, and $q > 2$ be a prime modulus. (The details is refer to the Proposition 1 [15], Definition 4 and Appendix A.)
2. For each attribute $u_k (u_k \in \mathcal{U})$, the local authority $Auth_k$ invokes the algorithm $TrapGen(n, m, q, \sigma)$ [15] to create a uniformly random $n \times m$ matrix $\mathbf{A}_{u_k} \in \mathbb{Z}_q^{n \times m}$ with a full-rank *m-vector* set $\mathbf{B}_{u_k} \subseteq \Lambda_q^{\perp}(\mathbf{A}_{u_k})$ which satisfies the low-norm condition $\left\|\tilde{\mathbf{B}}_{u_k}\right\| \leq m \cdot \omega(\sqrt{\log m})$, where σ is a Gaussian deviation parameter with $\Lambda(\mathbf{A}_{u_k})$. The local authority $Auth_k$ sends the matrix $\mathbf{A}_{u_k} \in \mathbb{Z}_q^{n \times m}$ to the central authority, and keeps $\mathbf{B}_{u_k} \subseteq \Lambda_q^{\perp}(\mathbf{A}_{u_k})$ as secret.
3. For a given access policy, the central authority selects a common uniformly random vector $\mathbf{u} \in \mathbb{Z}_q^n$ and a uniformly random integer $s \in \mathbb{Z}_q$, and publishes them as public parameters.
4. Finally the central authority outputs the system public parameters Pub, $Pub = \{\mathbf{A}_{u_k}, \mathbf{u}, s\}_{u_k \in \mathcal{U}}$.

And the secret key $Msk = \{\mathbf{B}_{u_k}\}_{u_k \in \mathcal{U}}$ is kept secretly by the local attribute authority separately.

- ***KP-ABE.Extract***$(Pub, \mathbf{B}_{\rho(i)}, (\mathbf{M}, \rho)) \rightarrow Key_{\rho(i)}$: This algorithm inputs the public parameters Pub, the master key Msk, and an access policy $(\mathbf{M}, \rho)$, where Pub and

$\mathbf{B}_{\rho(i)}$ is corresponding to the attribute $\rho(i)$ with the policy $(\mathbf{M}, \rho)$, and the maximum attribute bound of policy $(\mathbf{M}, \rho)$ is denoted by l, do:

1. For the LSSS access policy $(\mathbf{M}, \rho)$ on the universe attribute set $\mathcal{U}$, where $\mathbf{M}$ be a $l \times \theta$ matrix, called the share-generating matrix, and ρ be a function which maps the row number of matrix $\mathbf{M}$ to the universe attribute set $\mathcal{U}$, i.e. $\rho : [l] \to \mathcal{U}$, the i-th row of $\mathbf{M}$ will be assigned to a attribute $\rho(i) \in \mathcal{U}$.
2. The central authority constructs a new vector $\mathbf{v} = (s, v_2, v_3, \cdots, v_\theta)^T$,where $v_2, \cdots, v_\theta \in \mathbb{Z}_q$ are randomly chosen, and computes the matrix multiplication $\mathbf{M} \cdot \mathbf{v}$, denotes the result by $(\lambda_1, \cdots, \lambda_l)^T := \mathbf{M} \cdot \mathbf{v}$.
3. The central authority also constructs a new vector $\mathbf{w} = (0, w_2, \cdots, w_\theta)^T$, where $w_2, \cdots, w_\theta \in \mathbb{Z}_q$ are randomly chosen, and computes the matrix multiplication $\mathbf{M} \cdot \mathbf{w}$, denotes the result by

$$(\omega_1, \cdots, \omega_l)^T := \mathbf{M} \cdot \mathbf{w}.$$

   And denotes,

$$\mathbf{s}_i := [\lambda_i + \omega_i, 0, \cdots, 0]^T, i \in [l].$$

4. For each attribute $\rho(i)$, the authority $Auth_{\rho(i)}$ invokes the algorithm $SamplePre(\mathbf{A}_{\rho(i)}, \mathbf{B}_{\rho(i)}, \mathbf{s}_i, \sigma_i)$ [15] to generate $\boldsymbol{\xi}_{\rho(i)} \in \mathbb{Z}_q^m$ such that $\mathbf{A}_{\rho(i)}\boldsymbol{\xi}_{\rho(i)} \overset{\wedge}{=} \mathbf{s}_i$, where the distribution of $\boldsymbol{\xi}_{\rho(i)}$ is statistically close to $D_{\mathrm{A}_{\rho(i)}, \sigma_i, \mathbf{s}_i}$, and σ_i is Gaussian distribution parameter which satisfies $\sigma_i \geq \left\|\mathbf{B}_{\rho(i)}\right\| \cdot \omega(\sqrt{\log m})$.
5. Similarly, for each attribute $\rho(i)$, the authority $Auth_{\rho(i)}$ invokes the algorithm $SamplePre(\mathbf{A}_{\rho(i)}, \mathbf{B}_{\rho(i)}, \mathbf{u}, \sigma_i)$ to generate $\boldsymbol{\eta}_{\rho(i)} \in \mathbb{Z}_q^m$ such that $\mathbf{A}_{\rho(i)}\boldsymbol{\eta}_{\rho(i)} \overset{\wedge}{=} \mathbf{u}$, where the distribution of $\boldsymbol{\eta}_{\rho(i)}$ is statistically close to $D_{\mathrm{A}_{\rho(i)}, \sigma_i, \mathbf{u}}$, and Gaussian distribution parameter σ_i is the same as above.
6. Output the decryption keys $Key_{\rho(i)}$ of the attribute $\rho(i)$ for the policy $(\mathbf{M}, \rho)$, where

$$Key_{\rho(i)} = \{\boldsymbol{\xi}_{\rho(i)}, \boldsymbol{\eta}_{\rho(i)}\}, i \in [l].$$

- ***KP-ABE.Encrypt***$(Msg, Attrib, Pub) \to C_{tx}$: This algorithm inputs a message bit $Msg \in \{0, 1\}$, a subset of attributes $Attrib = \{u_{i_1}, u_{i_2}, \ldots, u_{i_t}\}$, and the public parameters Pub, do:

1. Select a uniformly random n-vector $\mathbf{x} \in \mathbb{Z}_q^n$.
2. Select a low-norm Gaussian noise scalar $\chi_1 \leftarrow \bar{\Psi}_\alpha$ and compute

$$C_1 = \mathbf{x}^T \cdot \begin{bmatrix} s \\ 0 \\ \vdots \\ 0 \end{bmatrix} + \mathbf{x}^T \mathbf{u} + \chi_1 + \left\lfloor \frac{q}{2} \right\rfloor Msg \mod q$$

3. Select a low-norm Gaussian noise vector $\chi_2 \leftarrow (\bar{\Psi}_\alpha)^{tm}$, and compute

$$C_2 = \mathbf{x}^T [\mathbf{A}_{u_{i_1}}, \mathbf{A}_{u_{i_2}}, \ldots, \mathbf{A}_{u_{i_t}}] + \boldsymbol{\chi}_2 \mod q,$$

4. Output the ciphertext C_{tx} for the list *Attrib*,

$$C_{tx} = \{C_1, C_2; Attrib\}.$$

- ***KP-ABE.Decrypt***$(Pub, Key, C_{tx}) \rightarrow b$: This algorithm inputs the public parameters *Pub*, the decryption key *Key* and the ciphertext $C_{tx} = \{C_1, C_2; Attrib\}$, here the key is a collection of some attribute key under a access policy $(\mathbf{M}, \rho)$, and those attributes are a subset of *Attrib*, and those attributes should satisfy the access policy $(\mathbf{M}, \rho)$, do:

1. As the subset of *Attrib* that corresponding to the key satisfies the policy $(\mathbf{M}, \rho)$ (i.e. *Attrib* be an authorized set), it is easy to find a linear combination of some rows of $\mathbf{M}$ that yields $[1, 0, \cdots, 0] \in \mathbb{Z}^\theta$, the rows are those corresponding to attributes in the subset. That is, there is l-vector $\mathbf{g}' = \left[g'_{\rho(1)}, \cdots, g'_{\rho(l)}\right]$ satisfies

$$\left[g'_{\rho(1)}, \cdots, g'_{\rho(l)}\right] \cdot \mathbf{M} = [1, 0, \cdots, 0]_{1\times\theta}.$$

From the above analysis, denote by

$$J = \left\{ j \middle| g'_{\rho(j)} \neq 0, j \in [l] \right\},$$
$$\rho(J) = \{\rho(j) | j \in J\}.$$

Then

$$\rho(J) \subseteq Attrib = \{u_{i_1}, u_{i_2}, \ldots, u_{i_t}\}.$$

2. In order to describe the above relationship clearly, here define a 1-1 mapping function $\varphi : J \rightarrow [t]$ such that

$$\rho(j) = u_{i_{\varphi(j)}}, j \in J, \varphi(j) \in [t].$$

Thus there is an inverse mapping φ^{-1} such that

$$u_{i_j} = \rho(\varphi^{-1}(j)).$$

3. For every $j \in J$, using the corresponding decryption keys $Key_{\rho(\varphi^{-1}(j))} = \left\{\boldsymbol{\xi}_{\rho(\varphi^{-1}(j))}, \boldsymbol{\eta}_{\rho(\varphi^{-1}(j))}\right\}$ of attribute $\rho(\varphi^{-1}(j))$ under the policy $(\mathbf{M}, \rho)$, compute

$$v \hat{=} C_1 - C_2[\mathbf{d}_1, \cdots, \mathbf{d}_t]^T - \frac{1}{\sum\limits_{j \in J} g'_{\rho(\varphi^{-1}(j))}} C_2[\mathbf{e}_1, \cdots, \mathbf{e}_t]^T \bmod q,$$

where

$$\mathbf{d}_j = \begin{cases} g'_{\rho(\varphi^{-1}(j))} \boldsymbol{\xi}^T_{\rho(\varphi^{-1}(j))}, & j \in J \\ \mathbf{0}, & j \notin J \end{cases}, \quad \mathbf{e}_j = \begin{cases} g'_{\rho(\varphi^{-1}(j))} \eta^T_{\rho(\varphi^{-1}(j))}, & j \in J \\ \mathbf{0}, & j \notin J \end{cases}.$$

And let v be an integer in $\left[-\left\lfloor \frac{q}{2} \right\rfloor, \left\lfloor \frac{q}{2} \right\rfloor\right]$.

4. Output the decrypted message bit b as

$$b = \begin{cases} 0 & |v| \le \left\lfloor \frac{q}{4} \right\rfloor \\ 1 & |v| \ge \left\lfloor \frac{q}{4} \right\rfloor \end{cases}.$$

4 Correctness and Security

4.1 Correctness

To establish correctness for decryption, we need to consider a suitable vector $\mathbf{g}$ satisfy $\mathbf{g}^{\mathrm{T}} \cdot \mathbf{M} = [1, 0, \cdots, 0]$,and the secret key $Key_{\rho(\varphi^{-1}(j))} = \left\{\boldsymbol{\xi}_{\rho(\varphi^{-1}(j))}, \boldsymbol{\eta}_{\rho(\varphi^{-1}(j))}\right\}$ corresponding to j-th attribute of *Attrib* satisfy the policy $(\mathbf{M}, \rho)$, compute

$$
\begin{aligned}
\varepsilon \hat{=} & C_1 - C_2[\mathbf{d}_1, \cdots, \mathbf{d}_l]^T - \frac{1}{\sum\limits_{j\in J} g'_{\rho(\varphi^{-1}(j))}} C_2[\mathbf{e}_1, \cdots, \mathbf{e}_l]^T \\
&= C_1 - C_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(l))}\right]^T \\
&- \frac{1}{g'_{\rho(\varphi^{-1}(1))} + \cdots + g'_{\rho(\varphi^{-1}(l))}} C_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(l))}\right]^T \\
&= C_1 - \mathbf{x}^T\left[\mathbf{A}_{\rho(\varphi^{-1}(1))}, \cdots, \mathbf{A}_{\rho(\varphi^{-1}(l))}\right]\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(l))}\right]^T \\
&\quad - \frac{1}{g'_{\rho(\varphi^{-1}(1))} + \cdots + g'_{\rho(\varphi^{-1}(l))}} \mathbf{x}^T\left[g'_{\rho(\varphi^{-1}(1))}\mathbf{A}_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\mathbf{A}_{\rho(\varphi^{-1}(l))}\right]\left[\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(1))}, \cdots, \boldsymbol{\eta}^T_{\rho(\varphi^{-1}(l))}\right]^T \\
&\quad - \chi_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(l))}\right]^T - \chi_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(l))}\right]^T \\
&= C_1 - \mathbf{x}^T\left[g'_{\rho(\varphi^{-1}(1))}\mathbf{A}_{\rho(\varphi^{-1}(1))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(1))} + \quad \cdots + \quad g'_{\rho(\varphi^{-1}(l))}\mathbf{A}_{\rho(\varphi^{-1}(l))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(1))}\right] \\
&\quad - \frac{1}{g'_{\rho(\varphi^{-1}(1))} + \cdots + g'_{\rho(\varphi^{-1}(l))}} \mathbf{x}^T\left[g'_{\rho(\varphi^{-1}(1))}\mathbf{A}_{\rho(\varphi^{-1}(1))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(1))} + \quad \cdots + \quad g'_{\rho(\varphi^{-1}(l))}\mathbf{A}_{\rho(\varphi^{-1}(l))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(l))}\right] \\
&\quad - \chi_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(l))}\right]^T \\
&- \frac{1}{g'_{\rho(\varphi^{-1}(1))} + \cdots + g'_{\rho(\varphi^{-1}(l))}} \chi_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(l))}\right]^T \\
&= \left\lfloor\frac{q}{2}\right\rfloor Msg + \chi_1 - \chi_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(l))}\right]^T \\
&- \frac{1}{g'_{\rho(\varphi^{-1}(1))} + \cdots + g'_{\rho(\varphi^{-1}(l))}} \chi_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(l))}\right]^T
\end{aligned}
$$

The above proof due to following conditions,

$$
\begin{aligned}
\left[g'_{\rho(\varphi^{-1}(1))}\mathbf{s}_1 + \ldots + g'_{\rho(\varphi^{-1}(l))}\mathbf{s}_l\right] &= \sum_{j=1}^{l} g'_{\rho(\varphi^{-1}(j))}\boldsymbol{\xi}_{\rho(\varphi^{-1}(j))} = \sum_{j=1}^{l} g'_{\rho(\varphi^{-1}(j))}\left[\lambda_{\rho(\varphi^{-1}(j))} + \omega_{\rho(\varphi^{-1}(j))}, 0, \cdots, 0\right]^T \\
&= \left[\sum_{j=1}^{l} g'_{\rho(\varphi^{-1}(j))}\left(\lambda_{\rho(\varphi^{-1}(j))} + \omega_{\rho(\varphi^{-1}(j))}\right), 0, \cdots, 0\right]^T = [s, 0, \cdots, 0]^T,
\end{aligned}
$$

where

$$
\begin{aligned}
\left[g'_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\right]\left[\lambda_{\rho(\varphi^{-1}(1))}, \cdots, \lambda_{\rho(\varphi^{-1}(l))}\right]^T &= \left[g'_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\right] \cdot \mathbf{M} \cdot \mathbf{v}^T = [1, 0, \cdots, 0]_{1\times l}[s, v_2, \cdots, v_l]^T = s, \\
\left[g'_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\right]\left[\omega_{\rho(\varphi^{-1}(1))}, \cdots, \omega_{\rho(\varphi^{-1}(l))}\right]^T &= \left[g'_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\right] \cdot \mathbf{M} \cdot \mathbf{w}^T = [1, 0, \cdots, 0]_{1\times l}[0, w_2, \cdots, w_\theta]^T = 0.
\end{aligned}
$$

Thus, to have a successful decryption, it suffices to set the parameters so that with overwhelming probability,

$$
|\varepsilon| \hat{=} \left|\chi_1 - \chi_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\xi}^T_{\rho(\varphi^{-1}(l))}\right]^T - \frac{1}{g'_{\rho(\varphi^{-1}(1))} + \cdots + g'_{\rho(\varphi^{-1}(l))}} \chi_2\left[g'_{\rho(\varphi^{-1}(1))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(1))}, \cdots, g'_{\rho(\varphi^{-1}(l))}\boldsymbol{\eta}^T_{\rho(\varphi^{-1}(l))}\right]^T\right| < \frac{q}{5}.
$$

4.2 Analysis of the Parameter

We will analyze the crucial system parameters in order to insure new scheme's correctness in this subsection. In new scheme, the security parameter is defined as λ, and the maximum of attribute bound with policy is defined as l, the rest of the parameters are set under the following constraints:

(1) For LWE hardness assumption, Gaussian noise distribution $\chi_i = \bar{\Psi}_{\alpha}^{m}$, with Gaussian parameter satisfies $\alpha \geq 2\sqrt{m/q}$. According to Regev's proof, the norm of χ_i satisfy $O(\alpha q\sqrt{m}) \leq 2m$ (see Proposition 2).

(2) For the algorithm $TrapGen(n, m, q, \sigma)$, we need $n = \Omega(\lambda)$, prime $q > 2$, lattice base dimension $m \geq 5n \log q$, standard deviation of discrete Gaussian distribution $\sigma = \frac{1}{\sqrt{2\pi}} \cdot \alpha$. If it satisfy to the dimension constraints of m, the output lattice from *TrapGen* algorithm [15] whose norm length is not more than $m \cdot \omega(\sqrt{\log m})$ (see Proposition 1 [15]).

(3) For Gaussian sample algorithm $SamplePre(\mathbf{A}, \mathbf{B}, \mathbf{u}, \sigma)$, for any prime $q = poly(n) \geq 2$ and $m \geq 5n \log q$, we need $\sigma \geq \left\|\tilde{\mathbf{B}}\right\| \cdot \omega(\sqrt{\log m})$, so that the norm length of extraction private key $key_i = \{\boldsymbol{\xi}_i, \boldsymbol{\eta}_i\}$ satisfy $||\boldsymbol{\xi}_i|| \leq \sigma\sqrt{m}$, $||\boldsymbol{\eta}_i|| \leq \sigma\sqrt{m}$ with overwhelming probability (see Lemma 2 [15]).

For convenience, let us write $g'_{\rho(\varphi^{-1}(j))}, \boldsymbol{\xi}^T_{\rho(\varphi^{-1}(j))}, \boldsymbol{\eta}^T_{\rho(\varphi^{-1}(j))}$ with $g'_{\rho(j)}, \boldsymbol{\xi}^T_{\rho(j)}, \boldsymbol{\eta}^T_{\rho(j)}$ for $j = 1, 2, \ldots, l$. Then, the $|\varepsilon|$ can be rewritten as

$$
\begin{aligned}
|\varepsilon| &\hat{=} \left| \chi_1 - \chi_2 \left[g'_{\rho(1)} \boldsymbol{\xi}^T_{\rho(1)}, \cdots, g'_{\rho(l)} \boldsymbol{\xi}^T_{\rho(l)} \right]^T - \frac{1}{g'_{\rho(1)} + \cdots + g'_{\rho(l)}} \chi_2 \left[g'_{\rho(1)} \boldsymbol{\eta}^T_{\rho(1)}, \cdots, g'_{\rho(l)} \boldsymbol{\eta}^T_{\rho(l)} \right]^T \right| \\
&\leq |\chi_1| + \left| \sum_{j=1}^{l} g'_{\rho(j)} \boldsymbol{\xi}^T_{\rho(j)} \mathbf{\chi}_2 \right| + \left| \sum_{j=1}^{l} g'_{\rho(j)} \boldsymbol{\eta}^T_{\rho(j)} \mathbf{\chi}_2 \right| \\
&\leq (q\alpha \cdot \omega(\sqrt{\log m}) + 1/2) + 2l(m^{1.5} \cdot \omega(\sqrt{\log m})(q\alpha \cdot \omega(\sqrt{\log m}) + \sqrt{m}/2)) \\
&\leq (q\alpha \cdot \omega(\sqrt{\log m}) + \sqrt{m}/2)(1 + 2l(m^{1.5} \cdot \omega(\sqrt{\log m})) \\
&\leq q\alpha(\omega(\sqrt{\log m}) + 1)(1 + 2l(m^{1.5} \cdot \omega(\sqrt{\log m}))
\end{aligned}
$$

If $|\varepsilon| < \frac{q}{5}$ holds, then α need satisfy

$$\alpha \leq \frac{1}{5}[(\omega(\sqrt{\log m}) + 1)(1 + 2l(m^{1.5} \cdot \omega(\sqrt{\log m}))]^{-1}$$

According to $q\alpha \geq \sqrt{m}/2$, we can deduce

$$q \geq \frac{5}{2}\sqrt{m}\left[(\omega(\sqrt{\log m}) + 1)(1 + l(m^{1.5} \cdot \omega(\sqrt{\log m}))\right]$$

If $|\varepsilon| < \frac{q}{5}$ holds, our scheme is correct. Thus we set n, m, σ, q, α as follows:

- The lattice dimension $m \geq 5n \log q$ and attributes upper bound l with the policy.

- The noise parameter of discrete Gaussian distribution $\alpha \leq \frac{1}{5}[(\omega(\sqrt{\log m})+1)(1+2l(m^{1.5}\cdot\omega(\sqrt{\log m}))]^{-1}$, and q be a prime $q \geq \frac{5}{2}\sqrt{m}[(\omega(\sqrt{\log m})+1)(1+l(m^{1.5}\cdot\omega(\sqrt{\log m}))]$, satisfying condition (1) above.
- $m = n^{1.5} \geq 5n\log q$, satisfying condition (2) above.
- $\sigma = \frac{1}{\sqrt{2\pi}}\cdot\alpha$, satisfying condition (3) above.

For the above parameters, it is not only satisfying the condition algorithm we used, but also can decrypt ciphertext correctly with overwhelming probability.

4.3 Security

In this subsection, we will prove the following theorem regarding the selective-security model for the key-policy ABE systems from lattices.

Theorem 1. *On the selective-security model, if there exists a PPT (probabilistic polynomial-time) algorithm in attacking against the above scheme with non-negligible advantage $\varepsilon > 0$, there exists a PPT that can solve the decision $(\mathbb{Z}_q, n, \chi)$-LWE problem with non-negligible advantage $\varepsilon/2$, where $\alpha = O(poly(n))$.*

Proof. In the decision $(\mathbb{Z}_q, n, \chi)$-LWE problem, the decision algorithm is given access to an unspecified sampling oracle $\mathcal{O}$, which is either a pseudo-random $\mathcal{O}_{\mathbf{x}}$ with carrying random secret $\mathbf{x} \in \mathbb{Z}_q^n$, or a truly random sampler $\mathcal{O}_{\$}$. To prove the theorem we will suppose that there exists a PPT adversary with non-negligible advantage ε to attack against our scheme in the selective-security model. By used the prowess of we will construct a PPT simulating algorithm decide $(\mathbb{Z}_q, n, \chi)$-LWE problem with non-negligible advantage. The reduction proceeds as follows.

Instance. The challenger requests oracle $\mathcal{O}$ and obtains LWE samples that we denote as,

$$
\begin{aligned}
[(\mathbf{w}_0, v_0)] &\in \left(\mathbb{Z}_q^n \times \mathbb{Z}_q\right) \\
\left[\left(\mathbf{w}_1^1, v_1^1\right), \cdots \left(\mathbf{w}_1^m, v_1^m\right)\right] &\in \left(\mathbb{Z}_q^n \times \mathbb{Z}_q\right)^m \\
\left[\left(\mathbf{w}_2^1, v_2^1\right), \cdots \left(\mathbf{w}_2^m, v_2^m\right)\right] &\in \left(\mathbb{Z}_q^n \times \mathbb{Z}_q\right)^m \\
&\vdots \\
\left[\left(\mathbf{w}_l^1, v_l^1\right), \cdots \left(\mathbf{w}_l^m, v_l^m\right)\right] &\in \left(\mathbb{Z}_q^n \times \mathbb{Z}_q\right)^m
\end{aligned}
$$

Target. The adversary announces a target challenge *Attrib**.

Setup. The challenger prepares the public parameter as follows.

(1) If attribute $u_i \in Attrib^*$, set the matrix $\mathbf{A}_{u_i} = [\mathbf{w}_i^1 | \ldots | \mathbf{w}_i^m]$, where $\mathbf{w}_i$ derive from the LWE samples of index i.

(2) If attribute $u_i \notin Attrib^*$, the challenger first generates integers $q = q(\lambda)$, error rate $\alpha = \alpha(\lambda)$, and sampling rate $\sigma = \sigma(\lambda)$ according to $Attrib^*$. And gets $(\mathbf{A}_{u_i}, \mathbf{B}_{u_i}) \leftarrow \mathrm{TrapGen}(n, m, q, \sigma)$.
(3) The challenger selects a common uniformly random vector $\mathbf{u} \in \mathbb{Z}_q^n$ and a uniformly random integer $s \in \mathbb{Z}_q$.
(4) The challenger returns the public parameter Pub to the adversary.

$$Pub = \left\{ \{\mathbf{A}_{u_i}\}_{u_i \in Attrib^*}, \mathbf{u}, s, q, \alpha, \sigma \right\}$$

Queries. The adversary is allowed to issue adaptive queries for a secret key $Key_{\rho(i)}$ by submitting attribute $\rho(i)$ to the challenger, where $\rho(i)$ is an attribute on its choice policy $(\mathbf{M}, \rho)$, as long as the target attribute list $Attrib^*$ does not satisfy. The challenger constructs and returns a secret key $Key_{\rho(i)}$ for each query policy $(\mathbf{M}, \rho)$ as follows.

(1) As in the real scheme, construct a LSSS matrix $\mathbf{M} \in \mathbb{Z}^{l \times \theta}$ from the access policy.
(2) Set $\mathbf{u} = \mathbf{w}_0$, where $\mathbf{w}_0$ be from LWE sample of index 0, and select a uniformly random integer s.
(3) Let $\kappa \hat{=} \{\rho(i_1), \rho(i_2), .., \rho(i_{num_0}) | 1 \le k \le num_0, 1 \le i_k \le l\}$ denote the number of attribute on choice police $(\mathbf{M}, \rho)$, compute the user private key $Key_{\rho(i_k)}$ for each attribute $\rho(i_k)$ on the query policy $(\mathbf{M}, \rho)$ as follows:

Compute $(\xi_{\rho(i_1)}, \xi_{\rho(i_2)}, \cdots, \xi_{\rho(i_{num_0})})^T$ by using sample algorithm, satisfy

$$[\mathbf{A}_{\rho(i_1)}, \mathbf{A}_{\rho(i_1)}, \cdots, \mathbf{A}_{\rho(i_{num_0})}] \begin{pmatrix} \xi_{\rho(i_1)} \\ \xi_{\rho(i_2)} \\ \vdots \\ \xi_{\rho(i_{num_0})} \end{pmatrix} = \begin{pmatrix} s \\ 0 \\ \vdots \\ 0 \end{pmatrix}.$$

Notability, in this step have to ensure the challenge attribute subset $Attrib^*$ do not satisfy the query policy $(\mathbf{M}, \rho)$, so here must exist at least one $\rho(i_k) \in \kappa$ and $\rho(i_k) \notin Attrib^*$, thus the challenger can use $\mathbf{B}_{\rho(i_k)}$, which is a short base on orthogonal lattice $\Lambda^{\perp}(\mathbf{A}_{\rho(i_k)})$, to compute a short base $\mathbf{T}_B$ on $[\mathbf{A}_{\rho(i_1)}, \cdots, \mathbf{A}_{\rho(i_j)}, \cdots, \mathbf{A}_{\rho(i_{num_0})}]$ by invoking algorithm $GenExtBasis(\mathbf{B}_{\rho(i_k)}, [\mathbf{A}_{\rho(i_1)}, \cdots, \mathbf{A}_{\rho(i_k)}, \cdots, \mathbf{A}_{\rho(i_{num_0})}])$. Lastly, the challenger compute a short vector $(\xi_{\rho(i_1)}, \cdots, \xi_{\rho(i_{num_0})})$ satisfy the above equation by using $SamplePreimage([\mathbf{A}_{\rho(i_1)}, \cdots, \mathbf{A}_{\rho(i_k)}, \cdots, \mathbf{A}_{\rho(i_{num_0})}], \mathbf{T}_B, (s, 0, \cdots, 0)^T, \sigma)$.

Similarly the challenger can get $(\boldsymbol{\eta}_{\rho(i_1)}, \boldsymbol{\eta}_{\rho(i_2)}, \cdots, \boldsymbol{\eta}_{\rho(i_{num_0})})^T$ by using sample algorithm $SamplePreimage([\mathbf{A}_{\rho(i_1)}, \cdots, \mathbf{A}_{\rho(i_k)}, \cdots, \mathbf{A}_{\rho(i_{num_0})}], \mathbf{T}_B, \mathbf{u}, \sigma)$, satisfy

$$\left[\mathbf{A}_{\rho(i_1)},\cdots,\mathbf{A}_{\rho(i_k)},\cdots,\mathbf{A}_{\rho(i_{num_0})}\right]\begin{bmatrix}\boldsymbol{\eta}_{\rho(i_1)}\\ \vdots\\ \boldsymbol{\eta}_{\rho(i_k)}\\ \vdots\\ \boldsymbol{\eta}_{\rho(i_{num_0})}\end{bmatrix}=\left(\mathbf{w}_0-\begin{bmatrix}h_1\\ h_2\\ \vdots\\ h_n\end{bmatrix}-\begin{bmatrix}s\\ 0\\ \vdots\\ 0\end{bmatrix}\right)\triangleq\mathbf{u}.$$

Thus the challenger can send the private key pair $(\xi_{\rho(i_k)},\eta_{\rho(i_k)})$ to each attribute $\rho(i_k)$ in attribute list κ on the query policy $(\mathbf{M},\rho)$.

Challenge. The adversary gives a sign in readiness for accepting a challenge, and specify a message $Msg^*\in\{0,1\}$ to encrypt. The challenger encrypts the message Msg for the challenge attributes $Attrib^*$. Let $\phi=|Attrib^*|$, then the challenger responds with a ciphertext $C^*_{tx}=(c^*_1,c^*_2)$ assembled form the LWE instance, as follow:

Let $c^*_1=v_0+\left\lfloor\frac{q}{2}\right\rfloor Msg^*$.

Let $c^*_2=\left[v^1_1,\cdots,v^m_1,\cdots,v^1_\phi,\cdots,v^m_\phi\right]$.

Note that, if the oracle $\mathcal{O}$ is a pseudo-random LWE oracle $\mathcal{O}_{\mathbf{x}}$ with embedded secret $\mathbf{x}\in\mathbb{Z}^n_q$, then

$$\begin{aligned}c^*_1&=v_0+\left\lfloor\frac{q}{2}\right\rfloor\cdot Msg^*=\mathbf{x}^T\mathbf{w}_0+\chi_1+\left\lfloor\frac{q}{2}\right\rfloor\cdot Msg^*\\&=\mathbf{x}^T\left(\begin{bmatrix}s\\0\\\vdots\\0\end{bmatrix}+\begin{bmatrix}h_1\\h_2\\\vdots\\h_n\end{bmatrix}\right)+\mathbf{x}^T\left(\mathbf{w}_0-\begin{bmatrix}h_1\\h_2\\\vdots\\h_n\end{bmatrix}-\begin{bmatrix}s\\0\\\vdots\\0\end{bmatrix}\right)+\chi_1+\left\lfloor\frac{q}{2}\right\rfloor\cdot Msg^*\\&=\mathbf{x}^T\begin{bmatrix}s+h_1\\h_2\\\vdots\\h_n\end{bmatrix}+\mathbf{x}^T\mathbf{u}+\chi_1+\left\lfloor\frac{q}{2}\right\rfloor\cdot Msg^*\end{aligned}$$

When $u_i\in Attrib^*$, v_i come from the genuine LWE oracle $\mathcal{O}_{\mathbf{x}}$, then $[v^1_i,\ldots,v^m_i]=\mathbf{x}^T[\mathbf{w}^1_i|\ldots|\mathbf{w}^m_i]+\chi_m=\mathbf{x}^T\cdot\mathbf{A}_{u_i}+\chi_2$. On the contrary, when the v_i come from a truly random sampler $\mathcal{O}_\$$. The distribution of $c^*_2=[v^1_1,\ldots,v^m_1,\ldots,v^1_\phi,\ldots,v^m_\phi]$ and $\mathbf{x}^T[\mathbf{A}_{u_1}\quad\mathbf{A}_{u_2}\quad\cdots\quad\mathbf{A}_{u_\phi}]+\chi_2 \bmod q$ is indistinguishable.

So that above encryption simulation is perfect.

Continuation is allowed continuing making further private key extraction queries, after having obtained the challenge ciphertext.

Decision eventually emits a guess, whether $C^*_{tx}=(c^*_1,c^*_2)$ was actually a valid encryption of $Msg^*\in\{0,1\}$ as requested, uses the guess to decide whether the LWE oracle was genuine.

If the adversary succeeds in guessing $Msg^* \in \{0,1\}$ with probability at least $\frac{1}{2}+\varepsilon$, then our decision algorithm will correctly guess the nature of the LWE oracle with probability at least $\frac{1}{2}+\frac{\varepsilon}{2}$. This concludes the proof of the security reduction.

4.4 Analysis of Efficiency

The above analysis of the new scheme in this paper shows that the lattice-based key-policy ABE scheme includes only linear operation. In order to explain the efficiency of the new scheme, we compare the new scheme with the scheme in the literature [16] in terms of space efficiency and time efficiency, as illustrated in Tables 1 and 2.

Here, n denotes the security parameter, $|Attrib|$ denotes the number of attributes in the encoding attribute list, l denotes the upper limit of all attributes, which satisfies with $|Attrib| < l, m$ denotes the dimension of the output lattice, k denotes the number of the attribute list which satisfy with the access policy. In the general case, k is a small number, the efficiency of decoding key of the new scheme is $O(n \times |Attrib|m)$, and the efficiency of the ciphertext storage space is $O(lm)$.

Table 1. Compare on space efficiency

Space efficiency	Public key	Master key	Private key	Ciphertext
Literature [16]	$O(nm \times l)$	$O(mm \times l)$	$O((l+1)m \times (l+1)m)$	$O((l+1)m)$
Our scheme	$O(nm \times l)$	$O(mm \times l)$	$O(lm)$	$O(lm)$

Table 2. Compare on time efficiency

Time efficiency	Encryption operation	Decryption operation
Literature [16]	$O(n \times (\|Attrib\|+1)m)$	$O(n \times (k+1)m \times (k+1)m)$
Our scheme	$O(n \times \|Attrib\|m)$	$O(n \times km)$

5 Conclusions

We have proposed a new key-policy ABE scheme from lattice according to the linear secret sharing mechanism, and proved the security of the new scheme under the LWE assumption. In contrast to the scheme in literature [16], we have used a different key generation algorithm on the access policy. Our scheme could support multi-authority attribute management. In the next step, we hope to construct an ABE scheme with attribute revocation from lattices, and a multi-authority ABE scheme with attribute revocation based on policy control.

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Improved Encryption Padding for ECC System with Provable Security

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Abstract. In order to solve the security problem of ECC cryptosystem, the security deficiency of elliptic curve encryption is described firstly in this paper. Then, the method of OAEP (Optimal Asymmetric Encryption Padding) in the random oracle model is adopted to enhance the security of the existing ECC encryption system. An improved encryption padding scheme for ECC cryptosystem, namely EOAEP (ECC OAEP), is proposed and designed in this paper, Under the one-way assumption of encryption function, it has been proved that our scheme satisfies adaptive chosen ciphertext security by using the Game-Hopping technology according to the random oracle model.

Keywords: Encryption · Padding scheme · Provable security · CCA2

1 Introduction

Since public-key cryptography is created, there have been some classic public key cryptosystems, such as RSA and ElGamal. Just as talked in [1], during a long period, many researchers could only use Shannon's information theory to provide secure mathematical proofs for these cryptosystems, where he proposed the concept of "perfect" privacy. However, this idea was very difficult to extend. Cryptologists began to reconsider the formal definition of cryptosystem security. Recently years, as [2, 3], many researchers tended to use provable security method to estimate the security of cryptosystem or protocol under the assumption of computational complexity theory.

There are many kinds of the precise formal definition of provable security. Generally, we discuss it under the framework of complexity theory, mainly considering PPT (Probabilistic Polynomial Time), Adversary, transformation algorithm, and the negligible success probability. This is a gradual viewpoint, and has been broadly accepted as explained in [4].

Suppose we construct an encryption scheme from a one-way function, security proof will be processed as follows:

(1) Assume that Adversary could break the encryption scheme in non-negligible probability;

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(2) Give a PPT specification, that is to say, construct a polynomial time algorithm by using Adversary, this algorithm could break the one-way encryption function with non-negligible probability;
(3) Prove the contradiction between step (2) with the one-way assumption of an encryption function. In the middle of 1990s, Bellare and Rogaway proposed the famous random oracle model methodology in [5, 6]. The provable security technology has been achieved great progress in the field of practical application. Many cryptographic algorithms with provable security have been proposed constantly. OAEP (Optimal Asymmetric Encryption Padding) was brought up at that period, and had been widely researched and applied.

OAEP is a randomized message padding technology, which mainly composes of two hash functions with feistel structure. Input plaintext m, random number r, as well as a redundant string of 0 which is used for the message authentication. Its structure can be shown in Fig. 1:

$$OAEP(m, r) = s \mid\mid t = (m||0^{k_1}) \oplus G(r) \mid\mid r \oplus H(s)$$

$$s = (m \mid\mid 0^{k_1}) \oplus G(r),$$

$$t = H(s) \oplus r$$

G, H respectively is Hash function: $G : \{0,1\}^{k_0} \rightarrow \{0,1\}^{n+k_1}$ $H : \{0,1\}^{n+k_1} \rightarrow \{0,1\}^{k_0}$. These two hash functions are assumed as a random oracle machine.

In this paper, we designed an improved ECC encryption padding scheme by introducing OAEP method, namely EOAEP(ECC OAEP). Under the one-way assumption precondition of encryption function, by means of the random oracle model, using Game-Hopping technology, we show that our scheme can resist the adaptive chosen-ciphertext attack.

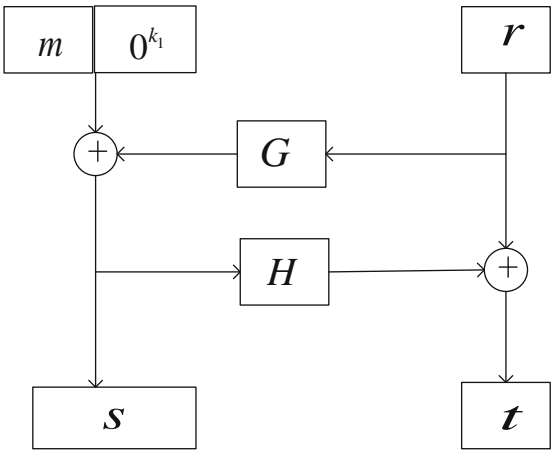

Fig. 1. Diagram of OAEP

2 Security Definition

We use the game method to describe IND-CCA2 (Indistinguishability-Adaptive Chosen Ciphertext Attack) security between the Adversary and Challenger. The game is as follows:

(1) ***Initialization***: Challenger produces system ε, Adversary acquires the public key;
(2) ***Firsrt Training Phase:*** Adversary launches decryption inquiries or decryption oracle machine to Challenger, namely sends ciphertext c to Challenger, then Challenger decrypts c, and returns the plaintext to Adversary;
(3) ***Challenge Phase:*** Adversary outputs two messages $m_0\, m_1$ which are of the same length, receives the c_b, ciphertext of m_b, from Challenger, where $b \in \{0, 1\}$;
(4) ***Second Training Phase:*** Adversary continues launching decryption inquiries or decryption oracle machine to Challenger, that is to say, gives the ciphertext $c(c \neq c_b)$ to Challenger. Challenger returns plaintext to Adversary after decryption operation;
(5) ***Guessing Stage:*** Adversary outputs b', if $b' = b$, then Adversary is successful.

Definition 1 (Negligible Function): For any polynomial $p(x)$, there is a positive integer N, if function $f(x)$ satisfies $p(k) \geq f(k) \geq 0$, $k > N$, then $f(x)$ is a negligible function.

Definition 2 (Advantage of Adversary): Advantage of adversary is defined as a function with parameter k:

$$Adv_{\varepsilon,A}^{CCA2}(k) = |\Pr[b = b'] - \frac{1}{2}|.$$

For any polynomial time adversary, if there is a negligible function $negl(k)$ satisfying $Adv_{\varepsilon,A}^{CCA2}(k) \leq negl(k)$, then this encryption algorithm is indistinguishable under adaptive chosen ciphertext attack, in other words, it satisfies CCA2 security.

Definition 3 (One-Way of Function): There are three assumptions about one-way of function:

(1) f is $(\tau, \varepsilon) - oneway$, if any Adversary could find the preimage of function $c = f(m)$ during time τ, and this kind probability is at most ε: $S^{ow}(\tau) = \Pr[m \leftarrow A(c)|c = f(m)] \leq \varepsilon$.
(2) f is $(\tau, \varepsilon) - partial - domain - oneway$, if any Adversary could find the preimage with k bits of function $c = f(m)$ during time τ, and this kind probability is at most: ε: $S^{pd-ow}(\tau) = \Pr[(m)_k \leftarrow A(c)|c = f(m)] \leq \varepsilon$.
(3) f is $(\tau, \varepsilon, l) - set - partial - domain - oneway$, if any Adversary outputs a set S with l elements, one of which is k bits preimage of function $c = f(m)$, and this kind probability is at most:

$$\varepsilon : \; S^{s-pd-ow}(\tau, l) = \Pr[(m)_k \leftarrow A(c), s \in (m)_k | c = f(m)] \leq \varepsilon.$$

According to [7, 8], for ECC cryptosystem, three definitions above are equivalent.

3 Ecc Encryption Scheme

In this section, we will give a brief review of ECC encryption algorithms, and analyze its security.

Keygen
Choose a elliptic curve E on F_q, a point $P = (x_p, y_p)$ on the curve, whose period is a big prime p. Choose an integer d in $[1, p-1]$ randomly, let $Q = dP$ (point addition). Then, public key is $pk = (E/F_q, P, p, Q)$, secret key is $sk = d$.

Enc

(1) Let m denotes a field element $m \in F_q$;
(2) Choose an integer k in interval $[1, p-1]$ randomly;
(3) Compute point $(x_1, y_1) = kP$ (point addtion) using public key pk. let $C_1 = (x_1, y_1)$;
(4) Compute $(x_2, y_2) = kQ$. if $x_2 = 0$, return step (2);
(5) Compute $C_2 = m \cdot x_2$;
(6) Ciphertext $C = (C_1, C_2)$.

Dec

(1) Compute point $(x_2, y_2) = d(x_1, y_1)$ using secret key $sk = d$;
(2) Compute x_2^{-1} on F_q;
(3) Compute $m = C_2 \cdot x_2^{-1}$.

Theorem 1. ECC encryption scheme doesn't satisfy CCA2 security.

Prove. If a cryptosystem is CCA2 security, then it can resist adaptive chosen ciphertext attack. The universality of all encryption schemes with IND-CCA2 security is their ciphertexts can pass valid test. So, we only need to show two valid ciphertexts can generate another ciphertext under ECC cryptosystem.

According to ECC encryption algrithm,

$$C_2^{'} = m^{'} \cdot x_2, \quad C_2^{''} = m^{''} \cdot x_2,$$

$$C_2^{'} + C_2^{''} = (m^{'} + m^{''}) \cdot x_2 = Enc(m^{'} + m^{''})$$

From above, it can be seen ECC encryption scheme does not satisfy CCA2 security.

4 Ecc Plaintext Padding Scheme

In this section, we will analyze ECC plaintext padding algorithm, as well as encryption and decryption process.

As above, ECC OAEP method also needs two hash functions G and H:

$$G : \{0,1\}^{k_0} \rightarrow \{0,1\}^{n+k_1} \quad H : \{0,1\}^{n+k_1} \rightarrow \{0,1\}^{k_0}$$

$$\begin{aligned} OAEP(m,k) &= s||t \\ &= (m \;||\; 0^{k_1}) \oplus G(k) \;||\; k \oplus H(s) \end{aligned}$$

Where, $s = (m \;||\; 0^{k_1}) \oplus G(k)$, $t = H(s) \oplus k$, $\omega = s \;||\; t$; the length of m is n; ρ is a string of zero redundance, whose length is k_1; k is a random integer, whose length is k_0. (See Fig. 2)

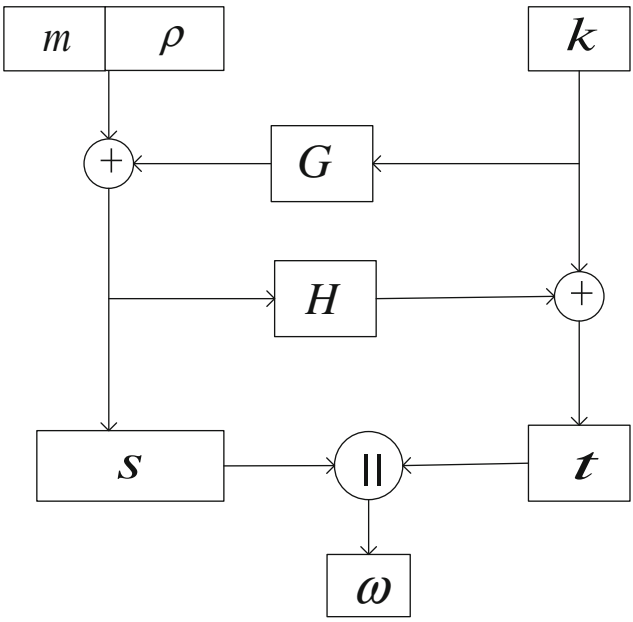

Fig. 2. Diagram of ECC OAEP

Message m can be encrypted by using public key $(E/F_q, P, p, Q)$ as follows:

(1) Let m denotes a field element $m \in F_q$;
(2) Choose an integer k in interval $[1, p-1]$ randly;
(3) Compute point $(x_1, y_1) = kP$ (point addition) using public key pk. let $C_1 = (x_1, y_1)$;
(4) Compute $(x_2, y_2) = kQ$. if $x_2 = 0$, return step (2);
(5) Compute $C_2 = m \cdot x_2$;
(6) Ciphertext $C = (C_1, C_2)$.

Ciphertext C can be decrypted by using secret key d as follows:

(1) Compute point $(x_2, y_2) = d(x_1, y_1)$ using secret key $sk = d$;
(2) Compute x_2^{-1} on F_q;
(3) Compute $\omega' = C_2 \cdot x_2^{-1}$, s' denotes the front $n + k_1$ bits of ω', t' denotes its latter k_0 bits.
(4) Compute $g = s' \oplus G(t' \oplus H(s'))$.
(5) If the latter k_1 bits of g is not a string of all zero, output "invalid ciphertext", otherwise, output the front n bits of g, namely m.

5 Security Proof

Gaining enlightenment from [9, 10], we also use the random oracle model to implement a security proof of our proposed ECC plaintext padding scheme. For every inquiry, random oracle machine tries to find if there happened the same previous inquire in its list firstly, if there doesn't, return a random value, then, add this inquire and value to the list; else, return the value in the list as the answer directly.

Assumption 1 (One-Way of ECC Encryption Algorithm): If the parameters of the ECC encryption algorithm are security, any Adversary could find a negligible function $f(x)$ and an enough big integer N to satisfy $S^{ow}(t) \leq f(N)$ in polynomial time t.

Based on this one-ways assumption, we can prove our scheme is secured under adaptive chosen ciphertext attack.

Theorem 2. Assume that CCA2 attacker in the ECC OAEP model could inquire separately q_H, q_G times from encryption oracle machine H and G, inquire q_D times from decryption oracle machine D. Under this condition, an attacker could break the semantic security in probability ε, then, there is an algorithm B could break the one-wayness of ECC encryption algorithm in time $q_D(q_G + q_H)(t_E + t_s)$, and this kind probability is at, mostly $(\varepsilon - \frac{q_G}{2^{k_0}} - \frac{1}{2^{k_1}} - \frac{q_G}{2^{k_0}})$, where t_E denotes the time to encrypt a plaintext, t_s denotes the time to search the list once.

Similarly with the security proof methods in [11–13], under random oracle model, we prove the security of ECC OAEP by using the Game-Hopping method. After defining a series of games, and changing the rules of the game step by step, the attacker's advantage can be translated into the probability to break encryption function's one-ways.

Prove. Assume the public key of encryption function E is pk, and sk denotes secret key. Adversary outputs two messages m_0 and m_1 which are of the same length, receives the ciphertext c_b of m_b from Challenger, where $b \in \{0, 1\}$. An Adversary needs to guess the value of b.

Game$_0$: Challenger choose $b \in \{0, 1\}$, $k^* \in \{0, 1\}^{k_0}$, $g^* = G(k^*)$, $s^* = (m_b || \rho^*) \oplus g^*$, $H(s^*) = h^*$, $t^* = h^* \oplus k^*$, $\omega^* = s^* || t^*$, $C_1^* = (x_1, y_1)$, $C_2^* = \omega^* \cdot x_2$ and ciphertext $c_b = (C_1^*, C_2^*)$. Then, adds (k^*, g^*), (s^*, h^*) separately into $G - list$, $H - list$, and sends c_b to Adversary. Adversary outputs a bit b' as the guess of b after receiving c_b.

Let S_0 denote the event $b' = b$, S_i in following games also denotes analogous event correspondingly. According to the definition,

$$\Pr[S_0] = \frac{1}{2} + \varepsilon$$

Game$_1$: Change the selection mode of k^* and g^*, choose $k^+ \in \{0,1\}^{k_0}$, $g^+ \in \{0,1\}^{n+k_1}$ in advance. When generating the ciphertext c_b, Challenger uses k^+ instead of k^*, g^+ instead of g^*. So, (k^*, g^*) in $G - list$ becomes (k^+, g^+), which has the same probability. Then,

$$\Pr[S_0] = \Pr[S_1]$$

Game$_2$: Generate the ciphertext c_b using (k^+, g^+) once more, Challenger does not add it into $G - list$. When Adversary inquires k^+ from G, G returns a random value to Adversary. At this time, m_b has nothing with c_b, so,

$$\Pr[S_2] = \frac{1}{2}$$

If Adversary inquires k^* from G, the returned values are different between *Game*$_2$ and *Game*$_1$. Let $AskG_2$ denote the event that Adversary asks k^* from G in *Game*$_2$, $AskG_i$ in following games also denotes analogous event correspondingly. Then,

$$|\Pr[S_2] - \Pr[S_1]| \leq \Pr[AskG_2]$$

Game$_3$: Challenger modifies *Game*$_2$, Challenger not only chooses $k^+ \in \{0,1\}^{k_0}$, $g^+ \in \{0,1\}^{n+k_1}$ in advance, uses k^+ instead of k^*, g^+ instead of g^*, but also chooses $s^+ \in \{0,1\}^{n+k_1}$, $h^+ \in \{0,1\}^{k_0}$ in advance, uses s^+ instead of s^*, h^+ instead of h^*. Then, adds (s^+, h^+) into $H - list$,

$$\Pr[AskG_3] = \Pr[AskG_2]$$

Game$_4$: Challenger modifies *Game*$_3$, Challenger does not add (s^+, h^+) into $H - list$. If Adversary asks s^* from H, the returned values are different between *Game*$_4$ and *Game*$_3$. Let $AskH_4$ denote the event that Adversary asks s^* from H in *Game*$_4$, $AskH_i$ in following games also denotes analogous event correspondingly. Then,

$$|\Pr[AskG_4] - \Pr[AskG_3]| \leq \Pr[AskH_4] \;\; \Pr[AskG_4] \leq \frac{q_G}{2^{k_0}}$$

Game$_5$: Challenger modifies *Game*$_4$, Challenger chooses $c^+ \in \{0,1\}^{n+k_1+k_0}$ randomly when generating ciphertext c_b, Let $c_b = c^+$. So, the following can be got:

$$\Pr[AskH_5] = \Pr[AskH_4]$$

$$\Pr[AskH_5] \leq S^{s-pd-ow}(q_H, t)$$

From the above equations,

$$\varepsilon - \frac{q_G}{2^{k_0}} \leq S^{s-pd-ow}(q_H, t)$$

When ε is non-negligible, this conclusion is inconsistent with *Assumption* 1. So, our ECC OAEP scheme satisfies IND-CPA security.

To prove its CCA2 security, decryption oracle machine D is necessary, Namely, Adversary asks ciphertext c from decryption oracle machine, then, decryption oracle machine returns corresponding plaintext after decryption operation. Decryption oracle machine can be achieved by constructing $D - list$.

If k does not been asked, the probability to construct valid ciphertext is $\frac{1}{2^{k_1}}$; If s does not been asked, the probability to construct valid ciphertext is $\frac{q_G}{2^{k_0}}$.

From above all, the following can be got:

$$S^{s-pd-ow}(q_H, t) \geq \varepsilon - \frac{q_G}{2^{k_0}} - \frac{1}{2^{k_1}} - \frac{q_G}{2^{k_0}}$$

Where, it is necessary to search $G - list$ and $H - list$ for $q_G + q_H$ times to every decryption operation, The time to encrypt a plaintext and to search a list is t_E and t_s separately, so, the time to perform decryption inquiry q_D times is $q_D(q_G + q_H)(t_E + t_s)$ accordingly.

6 Conclusions

The Traditional ECC encryption system can not resist adaptive chosen ciphertext attack, in order to solve this problem, an improved encryption padding scheme is proposed in this paper based on OAEP. Under the one-way assumption of ECC encryption function, it has been proved our scheme satisfies adaptive chosen ciphertext attack security by using the Game-Hopping technology in the random oracle model.

Existing plaintext padding schemes are almost based on the random oracle model, question and answer of the oracle machine are too idealistic, which causes the encryption scheme provable security in the random oracle model is probably not secure any more in practice. So, Structuring provable security scheme under the standard model is our next research direction.

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Security Test for Application Software Based on SPN

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Abstract. Security is an important attribute of software, some of the current software security testing methods are often based on the accurate parameters or on the basis of functional structure, and cannot adapt to the complex environment and safety requirements, particularly in scale distributed environment. Based on Stochastic Petri nets (SPN) theory, this paper analyzes the security of the application software by the SPN reliability measurement parameters, and then react upon the analysis and design of the software system, in order to explore a kind of application software security testing method based on SPN model. With example analysis, the method can find the disable system state or state combination intuitively, rapidly, and effectively, meanwhile, provides a new method for the application software security test.

Keywords: Stochastic petri nets · Application software · Security testing

1 Introduction

The generation, development and extensive application of giant complex, intelligent systems such as cloud computing, big data, the Internet of things and the physical information fusion system, shows the greatest changes in human lifestyle, represents the modern human life desire for the science and technology, especially the reliance on information technology as the core of life. At the same time, hardware products such as the microelectronics integration technology, required to meet the reliability requirement of scientific research and human activity, meanwhile, the security requirements of the software have been improved. Software security testing is a process to verify whether the software meets the expected functional requirements and security requirements, and discover potential security flaws in the software. It mainly includes User Authentication, System Network and Database security testing. Due to the different security requirements, test strategy is also different. Currently, the software security testing methods mainly include the static analysis, testing, the mode-based testing, the fuzzy testing, and the fault injection-based testing, the fault tree-based testing, penetration testing and so on.

Chen et al. [1] believe that the software testing by the fault injection may cause extra burden to the software, affect its performance, and produce intermittent error or uncertain error; Xu et al. [2] use the formal fault tree technology to explore software security requirement, and propose using the minimum cut set of security incidents to

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generate test cases; Yang et al. [3] derive threat behavior trajectory from known security threat model, and propose generating test cases according to certain test strategy, which is used to test whether program behavior is contained within the model library of security threats. Although these thinking methods provide some theoretical basis and method, however, it is not hard to find that these methods are based on some known parameters, and don't take the randomness of actual application of software into account.

Because of the software safety evaluation is subject to many factors, and the factor is random. Zhao et al. [4] has been proved that using Petri net (PN) not only can well describe the software architecture, but also present the software working process and the relationship between software modules at the same time. Wei et al. [5] further proves that using the PN method for software security analysis can quickly generate minimum cut set and test cases set. Therefore, this paper introduced SPN theory as the foundation to analyze the security testing of application software in terms of the failure of software security. Simulation results show that this method can maintain its consistency in various environments, with high precision and low-cost evaluation of the characteristics, and meanwhile provides a reliable and effective theory and method for the security software evaluation.

2 The Software Reliability Modeling and Measure Parameters Based on SPN

For a software system, whether the reliability testing early in the software, or the evaluation of reliability in the process control, since the environment and the choice of program path is random during its run time, therefore, the failure of software is random, and the running of system modules is a random process.

In the establishment of the SPN evaluation model, it can build reliability evaluation model of the software architecture based on the SPN according to the software elements. A simple software fault tree and the SPN model are shown in Fig. 1. In the model, a place S represents a module; token in place represents module control and the

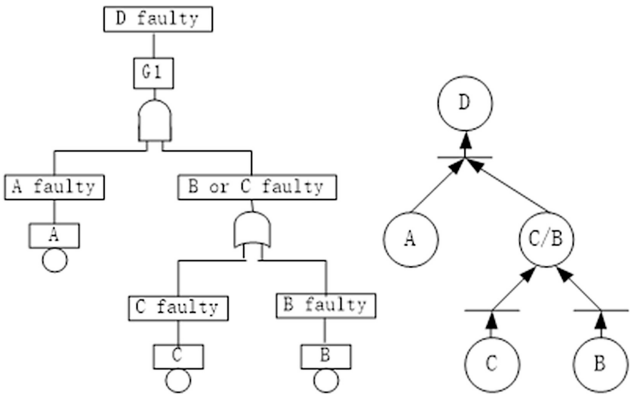

Fig. 1. Simple fault tree and petri net model

working state; transferring the token describes the paths and conditions in the running time. A transition T describes module process activities of the logical verification or testing, or the relationship between the modules, which modifies the module state. Therefore, the immediate transition is directly associated with the implementation of a logical condition in the testing of software reliability. An arc F describes the local state as well as the transfer of local, state caused by the operation.

Reference [6] defined that the SPN model of a software system is isomorphism to continuous time Markov chain as shown in Fig. 2.

	C	B	A	C/B	D
M0	1	1	1	0	0
M1	0	0	0	1	0
M2	0	0	0	1	0
M3	0	0	0	0	1
M4	0	0	0	0	1

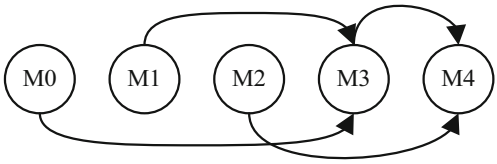

Fig. 2. Markov chain model of Fig. 1

Therefore, a transition is a continuous random variable from the implementable moment to implementation moment, and follows a distribution function:

$$F_i(x) = P(x_i \leq x)$$

On the other hand, according to the basic assumptions in [7–10], distribution function related to each transition can be defined as an exponential distribution function in the SPN model [11]:

$$\forall t \in T : F_i = 1 - e^{-\lambda_i x}$$

The actual parameter $\lambda_t \vee 0$ is the average firing rate of a transition t; variable $x \geqslant 0$ is a random variable from the enabling time t to time.

Let $S = \{1, 2, \cdots, n\}$ be a state sets of software, $W = \{1, 2, \cdots, k\}$ represent the working state of the system module, $F = \{k+1, k+2, \cdots, n\}$ represent the failure state of the software system, and $X(t)$ represent the system state at t time, i.e. $X(t)$ is a homogeneous Markova process that take S as state space. Let $p_i(t) = P[X(t) = i]$ be a probability of the state of i that is in the S at time t, $p_{ij}(t) = P[X(t + \Delta t) = j | X(t) = i]$ is a conditional probability of system in the state of j at time $(t + \Delta t)$, under the condition

that system is in a state of j at time t, and let $P(t) = (p_1(t), p_2(t), \cdots p_n(t))$ and $P(t+\Delta t) = P(t)Q(t)$ be the probability distribution of the state space when the system is in the time t, and

$$Q(t) = \begin{bmatrix} p_{1,1}(t) & p_{1,2}(t) & \cdots & p_{1,n}(t) \\ \cdots & \cdots & \cdots & \cdots \\ p_{i,1}(t) & p_{i,2}(t) & \cdots & p_{i,n}(t) \\ \cdots & \cdots & \cdots & \cdots \\ p_{n,1}(t) & p_{n,2}(t) & \cdots & p_{n,n}(t) \end{bmatrix} = [q_{ij}]$$

Obviously, when $\Delta t \to 0$,

$$\begin{cases} q_{ij} = \lim\limits_{\Delta t \to 0} \frac{p_{ij}(t+\Delta t)}{\Delta t} = \lambda_k & i \neq j \\ q_{ii} = \lim\limits_{\Delta t \to 0} \frac{1 - p_{ii}(t+\Delta t)}{\Delta t} = -\sum\limits_k \lambda_k & i = j \end{cases} \tag{1}$$

Where $k \in W$ describes a number of service provided by the system in the activity characterized by the transition. According to the general assumptions of software reliability evaluation model, there is:

Definition 1: If the tasks performed by each module of the software at a certain time all can meet the expected probability distribution, it's said that the software is available at the time.

Lemma 1: The availability of software system at the time t was the sum of probability of the normal running of each module in the software at the time.

$$A(t) = P[X(t) = j, j \in W] = \sum_{j \in W} p_j(t) \tag{2}$$

If $A_S = \lim\limits_{t \to \infty} A(t)$ exists, the steady state of system is available.

Because the state space of software is a homogeneous Markov process when it is running, when $\Delta t \to 0$, using the full probability formula is not difficult to prove that

$$\begin{cases} P(t) = \frac{dP(t)}{dt} Q^{-1} \\ P(0) = (p_1(0), p_2(0), \cdots, p_n(0)) \end{cases} \tag{3}$$

Matrix Q should be translated to Jordan canonical form and solve by Laplace transform when puzzled equation.

In continuous time SPN, it is not difficult to get the software reliability measured in the condition of $x_i(t)$:

$$R_i(t) = 1 - F_i(t) = e^{-\lambda_{ii} x_i(t)} \tag{4}$$

Thus the reliability measurement of the system can be obtained as follows:

$$R(t) = e^{\sum_i [\lambda_i(t) p_i(t)]} S \tag{5}$$

So, $\lambda_i(t)$ represents the transition rate of the i-th module at time t; $p_i(t)$ represents the effective probability for the working state of the i-th module at time t. So you can conclude that:

$$\text{Failure measure is:} \quad F(t) = 1 - R(t) = 1 - e^{\sum_i [\lambda_i(t) p_i(t)]} \tag{6}$$

$$\text{Failure intensity is:} \quad f(t) = \frac{dF(t)}{dt} \tag{7}$$

Mean time to first failure (MTTFF) is:

$$MTTFF = \int_0^t R(t) dt \tag{8}$$

Each place of SPN model implies two basic states: the steady-state and the failure-state. Therefore, the steady-state probability of software system at time t is p, then $S = \{p, 1 - p\}$. If the steady-state probability of each module in the time t is $p_i(t)$, the average failure interval of the software system is:

$$MTTBS = (I - P)(-Q)^{-1} \tag{9}$$

Through the analysis and measurement of reliability index, we can analyze the model of software reliability based on SPN and analyze software system situation until seeking out the effectiveness of state in design process.

3 Analysis of Software Security Based on SPN

The purpose of using SPN for software security analysis is to find out the state that cause software be untrusted and failed. According to the failure state, it can be used to direct the safety design and security testing of software, so that the software can achieve the expected security requirements. It is through the following steps using SPN to analyze and test the software:

First of all, we need to analyze the risk of software in order to confirm the security request of the software development and define the unsafe state of the software. At this stage, software designers need to have a certain understanding of the software design process, and determine unacceptably dangerous state of the according to the purpose of software design, security requirements and design specifications, etc.

Then, according to the process of software security analysis, we can establish the SPN model of the software, so as to construct software SPN reachability graph, the list sets of reachable markings for each marking in the reachability graph, analyze every

reachable state set, and find out the set of reachable marking sets which is easy to make the system fail.

Finally, according to the analysis of software failure state, we can go back to the software design stage, then apply the analysis of software reliability and security to software design and software testing, design test cases, strengthen the design and test of the module which is easy to cause the failure of software, and avoid state combination of software failure.

Through the analysis of trusted software modeling, state combination of software failure can be found out, so that the software designers can avoid combining failure state in the process of software design and improve the safety of software design.

4 Example

Because the security testing of the application software mainly includes user authentication testing, system network testing and database testing, in this paper, a simple user access control in application software was taken as application examples to illustrate the security testing method of application software based on SPN. Figure 3 is a simple logic operation flow chart of user security authentication in application software.

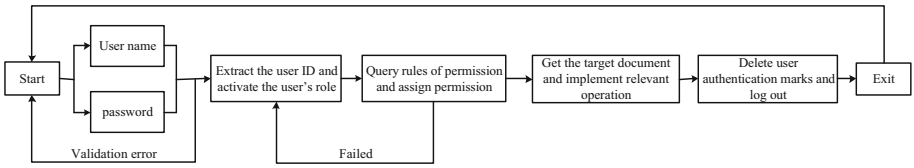

Fig. 3. The flowchart of logic operation of user security authentication

According to Fig. 3, the SPN model of the logical operation of user access control is established, as shown in Fig. 4. In the SPN description of the software architecture, a place represents each partial state of the software system; a transition is triggered for the software system from one state to another. In the running process of the whole software system, the token is constantly transferred; transfer is the function of a software to perform various operations in the running process. The specific process is as follows: user input user name and password for login authentication when using the application software; if the authentication is successful, the system will extract the user ID and activate the user's role, and then assign permission to the role, according to the set rules of permission; after obtaining permission, the user can carry out the corresponding operation; the system will delete user authentication marks and log out, and finally return to the initial state.

In Fig. 4, The place $P_1 \sim P_{10}$ represents state of software after each operation. The transition $t_2 \sim t_4$ are used to verify the software login user name and password. The transition $t_5 \sim t_{11}$ are operations to assign roles and access control permissions to a user. Operation process was used to simulate transitions of average firing rate in the whole operating process. Its place, transition and state are shown in the following Table 1,

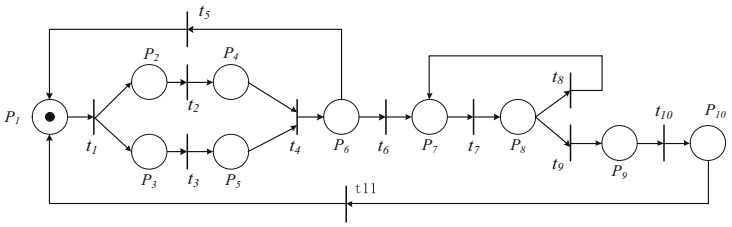

Fig. 4. The SPN model of logic operation of user access control

Table 1. The place, transition and states of reachability graph

Place	Transition	Change of the state
P_1	t_1	Enter the application software system by the t_1
P_2	t_2	Enter user name by the t_2
P_3	t_3	Enter password by the t_3
P_4	t_4	Verify the validity and correctness of the user name and password by the t_4
P_5		
P_6	t_5	User login validation failed, return to the initial state
	t_6	Extract the user's ID and activate the corresponding role by the t_6
P_7	t_7	Query permission rules of software system and divide permissions for each user
P_8	t_8	If permission division failed, system will re-extract the user ID for validation
	t_9	Obtain the corresponding document and do some related operation by the t_9
P_9	t_{10}	Remove the user's authentication flag and login out by the t_{10}
P_{10}	t_{11}	Return to the initial state

sets of reachable markings are listed in the Table 2. The average firing rate of transition is $\lambda = \{1, 2, 2, 3, 1, 3, 2, 1, 1, 1, 1\}$. According to formula (3), the steady-state probability formula, calculate the steady-state probability for each state with $P[M_0] = 0.1875$, $P[M_1] = P[M_2] = P[M_3] = 0.0468$, $P[M_4] = 0.0625$, $P[M_5] = 0.0468$, $P[M_6] = P[M_7] = P[M_8] = P[M_9] = 0.1406$, so that the reliability measurement of the access control module is $R(t) = 0.4286$.

According to the calculation results, the of access control reliability of software is low. The reason is that only use the basic identity authentication model, and the rules of the system permissions are not reasonable. Therefore, in the beginning of the software design, it should be added a variety of authentication methods, design good authority division rules, and design test cases to cover the two paths as much as possible to improve the security of software.

According to the theoretical analysis, example, the analysis and comparison of existing safety testing methods, as shown in Table 3, using SPN to analyze the security

Table 2. The sets of reachable markings of system

NO	Marks
M_0	(1,0,0,0,0,0,0,0,0,0)
M_1	(0,1,1,0,0,0,0,0,0,0)
M_2	(0,0,1,1,0,0,0,0,0,0)
M_3	(0,1,0,0,1,0,0,0,0,0)
M_4	(0,0,0,1,1,0,0,0,0,0)
M_5	(0,0,0,0,0,1,0,0,0,0)
M_6	(0,0,0,0,0,0,1,0,0,0)
M_7	(0,0,0,0,0,0,0,1,0,0)
M_8	(0,0,0,0,0,0,0,0,1,0)
M_9	(0,0,0,0,0,0,0,0,0,1)

Table 3. The comparison of common security testing methods

Security testing method	Scope of application	Advantages and disadvantages
Calculating mistakes	It mainly applies to the security function testing of software	Its process is greatly influenced by subjective factors, have higher request for the tester, and relies mainly on the experience of the tester
Syntax-based	It mainly applies to the software with a clear interface syntax	Its scope of use is limited, and it is suitable for the software with a clear interface syntax
Model-based	Its scope depends on the ability to model the security function, and it is applicable to the security function test of authorization, access control and so on	It removes the possibility of human error, but the test efficiency is low, the test model is difficult to establish, and it is difficult to test the system that exists infinite state
Theorem-based	It belongs to a formal method, and has a highly versatility	Its application scope is broad, but the test efficiency is low, the process of the proof of the theorem is time consuming, and it is difficult to realize the automation testing process
Fault tree analysis (FTA)	It is suitable for large-scale complex systems, such as flight control systems, medical monitoring systems, network intrusion detection, etc.	The search for the minimum cut set is heavy. The transformation from security requirement to formal fault tree and the analysis of the fault tree is hard
SPN model	The main features of SPN include asynchronous, parallelism, uncertainty and the ability to describe and analyze the distributed system, so it can be used in many practical systems	It has a wide range of application, strong simulation ability, can reduce the scope of risk analysis and identify the dangerous state. It is also conducive to the formation of a comprehensive test cases, and easy to achieve automated testing process

of application software is simple, intuitive and easy to understand, can reduce the scope of software security analysis, and also can easily find out the risk state of the software.

5 Conclusion

There are many methods of software security testing, but most of them have certain application scope and application conditions. In the random environment, how to effectively and quickly carry out software security testing is one of the problems to be solved. This paper proposes to use SPN to analyze the security of the software, in order to find out the module and the status which lead to software failure, and apply it to strengthen the design of the software module in the software design phase to avoid producing the software failure state. This kind of method not only can quickly find out location that easily leads to software failure and the cause of failure, reduce the risk of running software, but also can be applied to the software development process quickly, save the cost for the software development, and provides a new method for software security testing.

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A Novel Algorithm Enumerating Bent Functions Based on Value Distribution and Run Length

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Abstract. Bent function is an important nonlinear function in design of stream cipher and S-box. With more than eight variables Bent functions can only be generated by construction, where, most of these functions are still not found. In this paper, the Bent function search algorithm based on truth table is presented via analyzing the value distribution and run the length of the Bent function. Compared with other searching algorithms, the algorithm proposed in this paper has weak storage complexity and is easy to be implemented by parallel computing.

Keywords: Cryptography · Boolean functions · Bent functions · Walsh transformation · Run length · Parallel computing algorithms

1 Introduction

Bent functions are the Boolean functions with the highest nonlinearity and the strict avalanche criterion [1, 2]. Due to the Bent function can effectively resist the optimal affine approximation attack and the differential attack, it has been widely used in the design of S-box and stream ciphers. The classification and the construction are the research focuses on Bent functions. The search and the classification of 6-variable and 8-variable Bent functions have been done [3]. However, the search and the classification for more than ten variables Bent function are difficult, and such functions are constructed through Maiorana-McFarLand (M-M) class, partial spreads (PS) class, and so on [4–7]. Therefore, many properties for more than ten variables Bent functions haven't been discovered, and the study of enumerating Bent functions [8, 9] is an important work. Different from the work in [10], the distribution of the output value and the runs length of Bent functions are analyzed in this paper. At last, through these results, a new Bent function search algorithm is proposed.

The Bent functions search algorithm can be divided into two classes: based on algebraic normal form (ANF) and based on truth table. The search algorithm based on ANF: First give the search conditions, individually calculate the truth table which corresponds to the ANF, and then verify whether it is a Bent function by calculating the

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value of Walsh spectrum. Othaus points out that the algebraic number of n-variable Bent function is not greater than $n/2$, and the upper bound of (the number of) Bent function is $2^{2^{n-1}+\binom{n}{n/2}}$. By using the search algorithm based on this feature, the number of search ANF can be obtained, and it is the upper bound. Carlet and Klapper [11] reduced the upper bound of Bent function to $2^{2^{n-1}+\binom{n}{n/2}-2^{n/2}+n/2+1}(1+\varepsilon)+2^{2^{n-1}-\binom{n}{n/2}/2}$, but the reduction method is difficult to be implemented by computer. In [9], an improved Bent function search algorithm is proposed by the relationship between Walsh spectrum and its corresponding subroutines Walsh spectrum values. When searching 6-variables Bent function, its search number is $2^{32.3}$. The search algorithm based on truth table: verify whether the function which corresponds to the truth table is a Bent function by calculating the Walsh spectrum values via the truth table directly. In [10], the property of the Bent truth table is studied, and the approach of finding out the Bent function by adjusting the truth table and improving the nonlinearity of function is pointed out. Compared the two methods, due to the study of ANF property is more thorough than that of the truth table property, so the search scope of the search algorithms based on ANF is far less than that based on truth table. There are few research focus on the truth table study, however, the truth table method can avoid the process that calculates the truth tables by ANF, and it is more simple and efficient, therefore, the property of truth tables of Bent function still needs to be studied. In this paper, the truth table features of Bent function are introduced, then we focus on the distribution feature of the value and the runs length of Bent function, based on these studies, a Bent function search algorithm is proposed. Compared with the prior search algorithms, this algorithm has weak storage complexity and can be easily implemented by parallel computing.

2 Preliminaries

Let F_2 be the finite field with two elements, $F_2^n = \{(x_1, \ldots, x_n): x_i \in F_2, i = 1, \ldots, n\}$ denote the n-dimensional vector space. The ***Hamming weight*** of $x = (x_1, \ldots, x_n) \in F_2^n$ is denoted by $wt(x) = \sum_{i=1}^{n} x_i$, i.e., the number of 1 in the vector x. A Boolean function $f(x)$ of n variables is a mapping from F_2^n into F_2. B_n denotes the set of Boolean function of n variables. The basic representation of a Boolean function $f(x) \in B_n$ is by its ***truth table***, i.e., $f = [f(0, 0, \ldots 0), f(1, 0, \ldots 0), \ldots, f(1, 1, \ldots, 1)]$. The ***algebraic normal form*** (ANF) of Boolean function $f(x) \in B_n$ is denoted by $f(x) = f(x_1, x_2, \cdots, x_n) = a_1x_1 \oplus a_2x_2 \oplus \cdots \oplus a_nx_n \oplus a_{12}x_1x_2 \oplus a_{13}x_1x_3 \oplus \cdots \oplus a_{n-1n}x_{n-1}x_n \oplus \cdots \oplus a_{12\cdots n}x_1x_2\cdots x_n$, where $a_i \in F_2$, $x = (x_1, x_2, \ldots, x_n)$, $x_i \in \{0, 1\}$, $i = 1, 2, \cdots, n$, $\oplus$ denotes the sum over F_2.

The ***Hamming weight*** of Boolean function $f(x)$, denoted by $wt(f) = \#\{X_i | f(X_i) = 1\}$, i.e., is the number of 1 in its truth table. The Walsh transform $S_f(\omega)$ of $f(x) \in B_n$ is a

real-valued function and is defined as $S_f(\omega) = \sum_{x \in F_2^n} (-1)^{f(x)+x\omega}$, where $\omega \in F_2^n$, and $x\omega = x_1\omega_1 + x_2\omega_2 + \cdots + x_n\omega_n$. The inverse Walsh transform is defined as $(-1)^{f(x)} = \frac{1}{2^n}(\sum_{\omega} S_f(\omega)(-1)^{x\omega})$. While $f(x) \in B_n$, Parseval's relation applies to the Walsh transform of a Boolean function $f(x)$ giving $\sum_{\omega} S_f^2(\omega) = 2^{2n}$. Boolean function $f(x)$ is called ***balance***, if $S_f(0) = 0$. ***Nonlinearity*** of $f(x) \in B_n$ is minimum distance of affine function $f(x)$, by Walsh transform: $N_f = 2^{n-1} - \frac{1}{2}\max_{\omega} |S_f(\omega)|$.

Definition 1. Suppose $f(x) \in B_n$ be the Boolean function, then the following conditions are equivalent:

(1) $f(x)$ is a ***bent function***.
(2) The nonlinearity of $f(x)$ is $2^{n-1} - 2^{n/2-1}$.
(3) Hamming distance between $f(x)$ with all affine functions is $2^{n-1} \pm 2^{n/2-1}$.
(4) The absolute Walsh spectrum is $|S_f(\omega)| = 2^{n/2}$, where $\forall\omega \in F_2^n$.
(5) For any nonzero vector $a \in F_2^n$, satisfies $\sum_{x} (-1)^{f(x+f(x+a))} = 0$.

Definition 2. Set $f(x) \in B_n$ be a bent function, **1's run length** is the number of 1 which is consecutive in the truth table of $f(x)$. **0's run length** is the number of 0 which is consecutive in the truth table of $f(x)$. (For convenience **n's run length** is denoted the number of 1 which is consecutive in the truth table of $f(x)$ in the following text)

For example, given a 4-variables Bent function, the sequence is 10000001 00010111. Therefore, the 1's runs length is 3, and the 3's runs length is 1.

Proposition 1. Let $f(x) \in B_n$ be a bent function, then $wt(f) = 2^{n-1} - 2^{n/2-1}$ *or* $2^{n-1} + 2^{n/2-1}$.

Definition 3. Let $f(x) \in B_n$ be a bent function, while $x \in F_2^n$ and $S_f(\omega) = \pm 2^n$, the ***dual Bent function*** of $f(x)$ is

$$\tilde{f}(x) = \begin{cases} 0, & S_f(x) = 2^{n/2} \\ 1, & S_f(x) = -2^{n/2} \end{cases},$$

that is $S_f(x) = 2^{n/2}(-1)^{\tilde{f}(x)}$.

Proposition 2. If $f(x) \in B_n$ be a bent function, then the dual bent function is also a bent function.

Because the mapping from truth table to Walsh spectrum is a one-to-one mapping, by the Proposition 2, the analysis for the truth table sequence is equivalent to that for Walsh spectrum. The following Bent function sequences and properties of runs length also can be applied to the Walsh spectrum value sequence and the runs length (runs of $2^{n/2}$ and $-2^{n/2}$).

3 Distribution Properties of Output Value of Bent Functions

By Definition 1, we know Bent function has good properties. By analyzing its sequence, the following conclusions are obtained.

Theorem 1. Let $f(x) \in B_n$ be a Bent function. If $g(x_1, \cdots x_{2^{n-1}}, x_{2^{n-1}+1}, \cdots x_{2^n}) = f(x_{2^{n-1}+1}, \cdots x_{2^n}, x_1, \cdots x_{2^{n-1}})$, then $g(x_1, \cdots x_{2^{n-1}}, x_{2^{n-1}+1}, \cdots x_{2^n})$ is also a bent function.

Proof: $S_g(\omega_1, \cdots \omega_{2^{n-1}}, \omega_{2^n+1}, \cdots \omega_{2^n}) = \sum_x (-1)^{g(x)+x\omega}$. Because

$$\begin{aligned}
&g(x_1, \cdots x_{2^{n-1}}, x_{2^{n-1}+1}, \cdots x_{2^n}) + (x_1, \cdots x_{2^{n-1}}, x_{2^{n-1}+1}, \cdots x_{2^n})(\omega_1, \cdots \omega_{2^{n-1}}, \omega_{2^n+1}, \cdots \omega_{2^n}) \\
&= f(x_{2^{n-1}+1}, \cdots x_{2^n}, x_1, \cdots x_{2^{n-1}}) + (x_1, \cdots x_{2^{n-1}}, x_{2^{n-1}+1}, \cdots x_{2^n})(\omega_1, \cdots \omega_{2^{n-1}}, \omega_{2^n+1}, \cdots \omega_{2^n}) \\
&= f(x_{2^{n-1}+1}, \cdots x_{2^n}, x_1, \cdots x_{2^{n-1}}) + (x_{2^{n-1}+1}, \cdots x_{2^n}, x_1, \cdots x_{2^{n-1}})(\omega_{2^n+1}, \cdots \omega_{2^n}, \omega_1, \cdots \omega_{2^{n-1}})
\end{aligned}$$

Obviously, $S_g(\omega_1, \cdots \omega_{2^{n-1}}, \omega_{2^n+1}, \cdots \omega_{2^n}) = S_f(\omega_1, \cdots \omega_{2^{n-1}}, \omega_{2^n+1}, \cdots \omega_{2^n})$. We can get $g(x)$is a Bent function from Definition 1(4)

If $f(x) \in B_n$ be a Bent function, then $f(x) + 1$ is also a bent function. So analyzing $f(x)$ with $wt(f) = 2^{n-1} - 2^{n/2-1}$ is equal to analyzing $f(x)$ with $wt(f) = 2^{n-1} + 2^{n/2-1}$. In order to simplify the analysis procedures, we only consider the number of 1 is $wt(f) = 2^{n-1} - 2^{n/2-1}$, and define $S_1 = \{i | i \in [0, 2^{n-1} - 1]\}$, $S_2 = \{i | i \in [2^{n-1}, 2^n - 1]\}$.

Theorem 2. If $f(x) \in B_n$ be a Bent function, then the output value sequence of $f(x)$ satisfies $\underset{i \in S_1}{wt}(f(X_i)) = 2^{n-2}$ or $\underset{i \in S_1}{wt}(f(X_i)) = 2^{n-2} - 2^{n/2-1}$, $\underset{i \in S_2}{wt}(f(X_i)) = 2^{n-2}$.

Proof: Suppose $w_1 = wt(\{f(X_i) | i \in S_1\})$, $w_2 = wt(\{f(X_i) | i \in S_2\})$. As $w_1 + w_2 = 2^{n-1} - 2^{n/2-1}$ is known, let $g(x_1, \cdots, x_n) = x_n$, we can easily know value sequence of Boolean function is (0…01…1) and $wt(g) = 2^{n-1}$. For Definition 1(3), the relation between $f(x)$ and $g(x)$ is

$$dis(f, g) = \#\{i | f(X_i) \neq g(X_i)\} = 2^{n-1} - w_1 + w_2 = 2^{n-1} + 2^{n/2-1}$$

or

$$dis(f, g) = \#\{i | f(X_i) \neq g(X_i)\} = 2^{n-1} - w_1 + w_2 = 2^{n-1} - 2^{n/2-1}.$$

Solving it, we can get $w_1 = 2^{n-2}$, $w_2 = 2^{n-2} - 2^{n/2-1}$ or $w_1 = 2^{n-2} - 2^{n/2-1}$, $w_2 = 2^{n-2}$.

When $w_1 + w_2 = 2^{n-1} + 2^{n/2-1}$, following with above, we can get $w_1 = 2^{n-2}$, $w_2 = 2^{n-2} + 2^{n/2-1}$ or $w_1 = 2^{n-2} + 2^{n/2-1}$, $w_2 = 2^{n-2}$. □

The Theorem 2 shows that in the output sequence of Bent function, half of it is balanced, and the other half is the number of 1 is $2^{n-2} - 2^{n/2-1}$ or $2^{n-2} + 2^{n/2-1}$. In the Bent functions search algorithm, we can only analyze the case $\underset{i \in S_1}{wt}(f(X_i)) = 2^{n-2}$.

In the other case we can get it through Theorem 1. By this method, we can get the Proposition as below.

Proposition 3. Suppose $f(x) \in B_n$ be a Bent function, if $R_1 = \{i | i \bmod 2 = 1, i \in [0, 2^{n-1} - 1]\}$ and $R_2 = \{i | i \bmod 2 = 1, i \in [2^{n-1}, 2^n - 1]\}$, then $\underset{i \in R_1}{wt}(f(X_i)) = 2^{n-2}$ and $\underset{i \in R_2}{wt}(f(X_i)) = 2^{n-2} - 2^{n/2-1}$, or $\underset{i \in R_1}{wt}(f(X_i)) = 2^{n-2} - 2^{n/2-1}$ and $\underset{i \in R_2}{wt}(f(X_i)) = 2^{n-2}$.

Proposition 4. Suppose $f(x) \in B_n$ be a Bent function, if $R_1 = \{X_i | f(X_i) = 1, i \in [0, 2^n - 1]\}$, $R_2 = \{X_i | f(X_i) = 0, i \in [0, 2^n - 1]\}$ and $X_i = (x_1^i, x_2^i, \ldots x_n^i)$, then $\sum_{i \in R_1} x_j^i = 2^{n-2} - 2^{n/2-1}, 2^{n-2}, j \in [1, n]$, i.e., for any $X_i \in R_1$, the number of 1 in *j-th* component x_j^i *is* $2^{n-2} - 2^{n/2-1}$ *or* 2^{n-2}.

Proof: For $X_i = (x_1^i, x_2^i, \ldots x_n^i)$, let $\#\{x_j^i | x_j^i = 1, X_i \in R_1, j \in [1, n]\} = k$, then we can get $\#\{x_j^i | x_j^i = 0, X_i \in R_1\} = 2^{n-1} - 2^{n/2-1} - k$; $\#\{x_j^i | x_j^i = 1, X_i \in R_2\} = 2^{n-1} - k$, $\#\{x_j^i | x_j^i = 0, X_i \in R_2\} = 2^{n/2-1} + k$. From Definition 1(4),

$$\begin{aligned} S_f(\omega) &= \sum_x (-1)^{f(x) + x\omega} = \sum_{x \in R_1} (-1)^{f(x) + x\omega} + \sum_{x \in R_2} (-1)^{f(x) + x\omega} \\ &= \sum_{x \in R_1} (-1)^{x\omega} + \sum_{x \in R_2} (-1)^{1 + x\omega} \end{aligned}$$

While $\omega = (\omega_1, \omega_2, \ldots, \omega_n)$, $\begin{cases} \omega_i = 1, & i = j \\ \omega_i = 0, & i \neq j \end{cases}$,

$$\begin{aligned} S_f(\omega) &= \sum_{X_i \in R_1, x_j^i = 1} (-1)^{1 + X_i\omega} + \sum_{X_i \in R_1, x_j^i = 0} (-1)^{1 + X_i\omega} + \sum_{X_i \in R_2, x_j^i = 1} (-1)^{X_i\omega} + \sum_{X_i \in R_2, x_j^i = 0} (-1)^{X_i\omega} \\ &= k - [2^{n-1} - 2^{n/2-1} - k] - (2^{n-1} - k) + 2^{n/2-1} + k = \pm 2^{n/2} \end{aligned}$$

Solve it, $k = 2^{n-2} - 2^{n/2-1}, 2^{n-2}$. □

Proposition 4 shows that, in the Bent function sequences, if there exists the case that the function value is equal to 1 and the component of the corresponding vector is equal to 1, then the number of the component is fixed.

Theorem 3. Let $f(x) \in B_n$ be a Bent function and $n > 4$, we can get $\#\{X_i | f(X_i) = f(X_{i+n/2}) = 1, i \in S_1\} = 2^{n-3} - 2^{n/2-2}$, $\#\{X_i | f(X_i) = f(X_{i+n/2}) = 0, i \in S_1\} = 2^{n-3} + 2^{n/2-2}$ or $\#\{X_i | f(X_i) = f(X_{i+n/2}) = 1, i \in S_1\} = 2^{n-3} + 2^{n/2-2}$, $\#\{X_i | f(X_i) = f(X_{i+n/2}) = 0, i \in S_1\} = 2^{n-3} - 2^{n/2-2}$.

Proof: While $\#\{f(X_i) | f(X_i) = 1, i \in S_1\} = 2^{n-2} - 2^{n/2-1}$ and $\#\{f(X_j) | f(X_j) = 1, j \in S_2\} = 2^{n-2}$, suppose $\#\{X | f(X_i) = f(X_{i+n/2}) = 1, i \in S_1\} = k$. For $a = (10 \ldots 0)$ and $\#\{x | f(x) + f(x + a) = 1\} = 2^n$,

$$2 \times (2^{n-2} - 2^{n/2-2} - k) + 2 \times (2^{n-2} - k) = 2^{n-1}$$

Solve it, $k = 2^{n-3} - 2^{n/2-2}$. Likewise, we can get $\#\{X_i | f(X_i) = f(X_{i+n/2}) = 0, i \in S_1\} = 2^{n-3} + 2^{n/2-2}$. □

The Theorem 3 shows that the value of the Bent function is equal while the distance is $2^{n/2}$, that is $\#\{X_i | f(X_i) = f(X_{i+2^{n-1}}), i \in S_1\} = 2^{n-2}$.

4 Runs Properties of Bent Functions

Theorem 4. Suppose $f(x) \in B_n$ is a Bent function, then, there is no case that all run length generated by $f(x)$ are 1*'s* runs length, and the number of run length is less than or equal to 2^{n-2}.

Proof: From Definition 1(5), we have known $\sum_x (-1)^{f(x+a)+f(x)} = 0$.

(1) If all the components of Bent sequence are 1 and $a = (1\ldots00)$, then $wt(f(x) \oplus f(x + a)) = 2^n - 2^{n/2} > 2^{n-1}$. The contradiction emerges.
(2) Suppose the maximum number of 1's runs length is k. From $wt(f(x) \oplus f(x + a)) = 2^{n-1} \geq 2k$, we can get $k \leq 2^{n-2}$. □

Theorem 5. If $f(x) \in B_n$ $(n > 3)$ be a Bent function, then 1*'s* run length is less than $2^{n-2} - 2^{n/2-2}$.

Proof: Let $S = \{X_j | f(X_j) = 1, j = i, i + 1, \ldots, i + 2^{n-2} - 2^{n/2-2}\}$. While a = $(0\ldots01)$, $\sum_x (-1)^{f(x+a)+f(x)} = \sum_{x\in S} (-1)^{f(x+a)+f(x)} + \sum_{x\notin S} (-1)^{f(x+a)+f(x)}$.

(1) If j is even, then

$$\sum_{x\in S} (-1)^{f(x+a)+f(x)} = 2^{n-2} - 2^{n/2-1}$$

$$\sum_{x\notin S} (-1)^{f(x+a)+f(x)} \geq (2^n - (2^{n-2} - 2^{n/2-2}) - 2 \times (2^{n-2} - 2^{n/2-2})) - 2 \times (2^{n-2} - 2^{n/2-2})$$

$$= 2^n - 2^{n-2} + 2^{n/2-2} - 2^{n-1} + 2^{n/2-1} - 2^{n-1} + 2^{n/2-1}$$

$$= 2^{n/2} + 2^{n/2-2} - 2^{n-2}$$

We can get $\sum_x (-1)^{f(x+a)+f(x)} \geq 2^{n-2} - 2^{n/2-1} + 2^{n/2} + 2^{n/2-2} - 2^{n-2} = 2^{n/2-1} + 2^{n/2-2} \neq 0$.

(2) If j is odd, then

$$\sum_{x\in S}(-1)^{f(x+a)+f(x)} = 2^{n-2} - 2^{n/2-1} - 4$$

$$\sum_{x\notin S}(-1)^{f(x+a)+f(x)} \geq (2^n - (2^{n-2} - 2^{n/2-2}) - 2 - 2\times(2^{n-2} - 2^{n/2-2})) - 2\times(2^{n-2} - 2^{n/2-2})$$

$$= 2^n - 2^{n-2} + 2^{n/2-2} - 2^{n-1} + 2^{n/2-1} - 2^{n-1} + 2^{n/2-1} - 2$$

$$= 2^{n/2} + 2^{n/2-2} - 2^{n-2} - 2$$

$$\sum_{x}(-1)^{f(x+a)+f(x)} = 2^{n-2} - 2^{n/2-1} - 4 + 2^{n/2} + 2^{n/2-2} - 2^{n-2} - 2 = 2^{n/2-1} + 2^{n/2-2} - 6$$

While $n > 6$, $\sum_{x}(-1)^{f(x+a)+f(x)} \neq 0$. □

The quantity of Bent function search can be reduced by applying Theorems 4 and 5.

5 Enumeration Algorithm of Bent Functions

5.1 Pretreatment

(1) Set the length of bent functions to be n (n is an even) Let the Walsh spectrum absolute value of the Bent function be $SF = 2^{\frac{n}{2}}$.

(2) Initialize the initial value and final value of beginning part and ending part of Bent function. In the beginning part, let $fSectBegin = \underbrace{1\cdots1}_{2^{n-2}}\underbrace{0\cdots0}_{2^{n-2}}$ and $fSectEnd = \underbrace{0\cdots0}_{2^{n-2}}\underbrace{1\cdots1}_{2^{n-2}}$. In the ending part, let $bSectBegin = \underbrace{1\cdots\cdots1}_{2^{n-2}-2^{n/2-2}}\underbrace{0\cdots\cdots0}_{2^{n-2}+2^{n/2-2}}$ and $bSectEnd = \underbrace{0\cdots\cdots0}_{2^{n-2}+2^{n/2-2}}\underbrace{1\cdots\cdots1}_{2^{n-2}-2^{n/2-2}}$. If we enumerate Bent functions in an interval, initialization value of two parts can be assigned by the known truth table sequence of Bent functions.

(3) Initialize the shifting setting. In the beginning part, set shifting length $fLenMark = 1$, starting position $fBeginPostion = 2^{n-2}$, termination position $fEndPostion = 2^{n-2}$; in the ending part, set shifting length $bLenMark = 1$, starting position $bEndPostion = 2^n$, termination position $bEndPostion = 2^n$; Set the maximum runs of length $maxLen = 2^{n-2} - 2^{n/2-2}$ and the maximum of the runs of length $maxOneRunLength = 2^{n-2}$.

5.2 Processing

(1) Set the initial value of the two parts, $fSect = fSectBegin$, $bSect = bSectBegin$, $bSect = bSectBegin$, then go to step (2)

(2) Let wt($fSect \oplus bSect$) denote the number of the components which are equal at the same position of sequences $fSet$ and $bSect$, if $wt(fSect \oplus bSect)$ is not equal to 2^{n-2}, go to step (5), else, go to step (3)

(3) Calculate the Walsh spectrum of the sequence *fSect*||*bSect*. If the value isn't equal to SF, go to step (5), else, go to step (4)
(4) Output the sequence *fSect*||*bSect*, then go to step (5)
(5) The *bSect* shifts to right (see Remark 2) If *bSect* isn't equal to *bSectEnd*, go to step (2), else, go to step (6)
(6) The *fSect* shifts to right (see Remark 2) Determine whether *fSect* is equal to *fSectEnd*, if it is, then exit the algorithm, if not, then, go to step (2)

Remark 1. Find out a group of *fSect*, *bSect*four, the corresponding Bent functions, i.e., *fSect*||*bSect*, *bSect*||*fSect*, and the sequences which invert the prior two sequences by every bit. If the 6-variable Bent function value sequence is 10100101001111001001 10011001011011110000110011001010101000000000, then the sequences 111100001 10011001010101000000000101001010011111001001100110010110, 1111000011001 10010101010000000001010010100111100100110011001011 0 and 00001111001100 11010101011111111110101101011 00 00110110011001101001 should be outputted.

Remark 2. The shift operation in the beginning part is that let *bLen* = *bLenMark*, *fSect* shift right from *fBeginPostion* with length *bLen* until the right bit is 1 or the position of right bit is *bEndPostion*. Let *bLen* = *bLen* − 1, iterate the step as above until *bLen* = 0. In the ending part, shift operation is the same as that in the beginning part. Let *bLenMark* = *bLenMark* + 1, *fBeginPosition* = *fBeginPosition* − 1, iterative the step above until *fBeginPosition* $\leq$ 0.

Remark 3. In the process of the shifting the sequences, if the maximum of the runs length sequence is greater than *maxLen*, or the number of the 1's runs length is greater than *maxOneRunLength*, then the shifting process is end and go to the next shifting process.

Remark 4. In the pre-processing stage, *fSectBegin* and *fSectEnd* are decomposed into multiple groups, and the rest of the algorithm is not changed, so the algorithm can be directly replaced by a parallel algorithm, and the efficiency of the algorithm can be improved. For example, set $fSectBegin_0 = \underbrace{1\cdots1}_{2^{n-2}}\underbrace{0\cdots0}_{2^{n-2}}$, $fSectEnd_0 = 1\underbrace{0\cdots0}_{2^{n-i}}\underbrace{1\cdots1}_{2^{n-2}-1}\underbrace{0\cdots0}_{2^{n-2}-2^{n-i}}$, $fSectBegin_1 = 1\underbrace{0\cdots0}_{2^{n-i}}\underbrace{1\cdots1}_{2^{n-2}-2}01\underbrace{0\cdots0}_{2^{n-2}-2^{n-i}-1}$, ..., $fSectEnd_m = \underbrace{0\cdots0}_{2^{n-2}}\underbrace{1\cdots1}_{2^{n-2}}$.

5.3 Complexity Analysis of the Algorithm

The number of sequences, which satisfies the Theorems 2 and 3, is $\binom{2^{n-2}}{2^{n-1}}\binom{2^{n-3}-2^{n/2-2}}{2^{n-2}}\binom{2^{n-3}-2^{n/2-2}}{2^{n-2}}$. Therefore, the number of sequence, which needs to calculate the Walsh spectrum, is

$$\begin{aligned}
&\binom{2^{n-2}}{2^{n-1}}\binom{2^{n-3}-2^{n/2-2}}{2^{n-2}}\binom{2^{n-3}-2^{n/2-2}}{2^{n-2}}-\binom{2^{n-2}-2^{n/2-1}}{2^n-2^{n-2}}-\binom{2^{n-2}-2^{n/2-2}+1}{2^n-2^{n-2}+2^{n/2-2}}\\
&=\frac{1}{\sqrt{\pi^3}}2^{2^{n-1}+2^{n-2}-2^{n/2+1}-n+4}-\frac{1}{e^{2^{n-1}}\sqrt{\pi}}\sqrt{\frac{2^{n+1}-2^{n-1}}{2^{2n-1}-2^{n+n/2-1}+2^n}}\frac{(2^n-2^{n-2})^{2^n-2^{n-2}}}{(2^{n-2}-2^{n/2-1})^{2^{n-2}-2^{n/2-1}}(2^{n-1}+2^{n/2}-1)^{2^{n-1}+2^{n/2-1}}}\\
&-\frac{1}{\sqrt{\pi}}\sqrt{\frac{2^{n+1}-2^{n-1}+2^{n/2-1}}{(2^n+2^{n/2}-1)(2^{n-1}-2^{n/2-1}+2)}}\frac{(2^n-2^{n-2}+2^{n/2-2})^{2^n-2^{n-2}+2^{n/2-2}}}{(2^{n-1}+2^{n/2-1}-1)^{2^{n-1}+2^{n/2-1}-1}(2^{n-2}-2^{n/2-2}+1)^{2^{n-2}-2^{n/2-2}+1}}
\end{aligned}$$

When $n = 6$, the number of the sequences is about $2^{55.1}$. When $n = 8$, the number of the sequences is about $2^{244.1}$. Compared with the search algorithm based on ANF [1, 9], the search scope is still large, but it avoids calculating the truth table by the ANF, and it can be easily implemented by computer. Therefore, this algorithm has a higher availability. Compared with [11], our algorithm narrows the search scope and has better efficiency. Finally, since the number of Bent function is a smart part in the search scope, the Bent function sequence and the run length properties which are analyzed in this paper can be used to improve the search efficiency of the algorithm based on ANF. When we judge whether the search function is a Bent function, all the functions which do not satisfy the sequence and runs a length property can be discarded directly, then the larger amount of Walsh spectrum value calculations can be avoided, and the search efficiency also can be improved.

6 Conclusions

In this paper, the properties of the run length and the value of the Bent functions are given. By analyzing the Bent function value sequence and the run length properties, a search algorithm based on truth table is proposed. Compared with the existing search algorithm based on truth table, our algorithm has the advantage of a smaller search scope, easy implementation, and high availability. These properties can be used as filter conditions in the Bent function search algorithm based on ANF, then a large amount of Walsh spectrum value calculations can be avoided. Therefore, the efficiency of the algorithm can be improved. Of course, the number of search functions is still greater than the upper bound of Bent function by the proposed algorithm. We will continue to study the truth table properties of Bent functions to narrow the search scope of search function.

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Real-Time Decision Support

The Application of Artificial Intelligence and Intelligent Decision in Men Volleyball's Lineup Tactics

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Abstract. With the continuous improvement of modern athletic volleyball, competition becomes increasingly fierce. This leads to consistent development of attacking tactics and determines that in most cases, relying on single athlete's performance can hardly finish the whole attacking process. The combination and coordination of multiple attacking tactics play a significant role in the implementation and success of athletic volleyball attacking tactics. This article begins with the development process of volleyball in China, changes of technical guiding method and technical tactics, current situation of Chinese volleyball's development. Based on the comparative research on the diagnostic method for artificial intelligent competitive tech-technical in volleyball, the article improves the diagnostic method for artificial volleyball tech-technical tactics to use of artificial nervous network and brings out that it should make various diagnose according to different competition situation and then give an evaluation and a predictive research.

Keywords: Artificial intelligence · Volleyball match · Techniques and tactics · Artificial nervous networks

1 Introduction

The research on volleyball techniques and tactics has realized the process of quality decision and then quantity decision of forming a mixture between these two. The method also changes from simply taking advantage of manual design in making advantages of modern calculating methods and computing technology. The computing simulative diagnostic in ball match provides new direction for technique-tactics diagnose in volleyball matches. Some of research tries to combine the nervous network method with computing simulative diagnose in ball match. While index in technique and tactics constraints its application in match and exercise [1].

Investigating research on diagnosing and evaluation by using artificial intelligence methods, and diagnosing the technical, tactical level about excellent athletes supports a reasonable exercising plan for both athletes and trainers help to effectively control the usage of technology in the technical tactical match. The article aims at helping the Chinese team to be great again, to give a direction for its development and revolution in the future, to set a direct method for the technical improvement and to give advice on

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its development. This article by going through the passing evolution of the Chinese volleyball of the past half of a century, analyzes new characteristics under new regulations of modern volleyball. It points out that the level of men's volleyball in China declines sharply. First of all, the decline shows on wrong guiding thoughts, and then simply imitate the methods in Europe, but abandons its traditional features, what's more, failing on the control of developmental rules and the trend in evolution of technique and tactics in volleyball [2].

First of all include the origin of the tactics. As a tactical confrontation and combat action methods, the first originate from human nature in order to survive and fight activities, particularly in the human Venetic period, humans and other animal confrontation in order to capture those survive animals or in order to avoid those ferocious beast attack, human use is different from other animal intelligence and wisdom, created with the special significance and role of various mode of action. As the British scholar Jacob Bronovskiy pointed out: "such as the slowest human animal, only rely on the collective cooperation, in order to discover, search, and capture a huge animal running in the vast wilderness. Hunting activities need to be consciously planned and arranged by the language, to be assembled in groups, and to make special weapons. Humans can use language, remind each other, and coordinate actions.

Hunting is a collective activity, the climax of this activity is to make a concerted effort to kill the prey". In the collective activities of human gradually produced a division of labor, thus opening the mating behavior. In order to capture a variety of different prey, humans have to adopt a different mode of action, perhaps a personal action, but also perhaps a collective action. These ways of action from the initial individual experience summary of the progressive development of the mode of fighting for the group, and in the form of life education from generation to generation to pass down, these specific forms of action will form a prototype of the tactics.

2 Materials and Methods

2.1 Diagnose of Techniques and Tactics and Assessment

With the development of modern advanced science and technology and theory gradually in the sports field, scientific training "gold content" has become the victory and the club's long-term survival. In volleyball, the diagnosis of their technical and tactical science is the scientific training system is an important part of the system, is also the key point and the difficulty, scientific training, management of volleyball height depends on the quantitative diagnosis. At the end of last century, Tian Maijiu, a specialist in training, put forward that the accurate diagnosis is the premise of improving the technology and tactics, because there is no scientific diagnosis, and the effective control of the training process is not possible. Obviously, the diagnosis is important in the whole training process. At the same time, it can be known that "accuracy" is the most basic standard to judge whether the diagnosis is scientific or not. At present, in accordance with the source material to evaluate the diagnostic evaluation of competitive sports is divided into: qualitative diagnosis and quantitative diagnosis, the former is based on the evaluation method of the subjective experience of coaches

and experts of sports, athletes' competitive state, the latter is an effective and accurate records on the basis of digging from the competition and training data on which the whole sports teams or athletes' competitive state. By consulting the literature, we can learn that most of the technical and tactical level of diagnostic research is mostly qualitative description, in order to evaluate and speculative in the majority. In fact, quantitative diagnostic research has always been a major problem in the research of ball games. Marx once said: "without the use of mathematical science cannot be called science". In order to improve the level of technical and tactical training, the use of accurate data to reflect the objective state of the technical and tactical skills, and to build an accurate digital diagnostic model has become an urgent task for the implementation of scientific training.

The individual diagnostic evaluation goes only from a certain point of the game, it can reflect the technical and tactical aspects of a volleyball play regarding his or her strength, but it can't make its overall assessment. It requests a comprehensive game evaluation method. Because of the specificity of volleyball, its technical and tactical strength may reflect different sides, for offensive players, from the ability to grab a positive situation, to answer the ball and the ability of counter-balance. This makes a different approach in the comprehensive assessment. But the common principle is both to reflect the overall technical and tactical strength on athletes and be applicable to more types of game. When doing a volleyball match technical and tactical evaluation, it must first select an appropriate analysis system according different objects and different needs. For example, to assess opponent's technics (see Fig. 1), we need to use technology application system; to analyze an offensive one, we need the three-stage system.

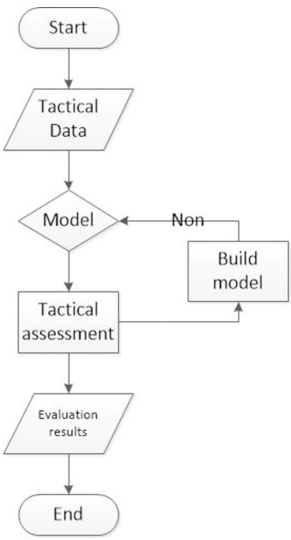

Fig. 1. Technical and tactical evaluation process of volleyball match

2.2 Artificial Intelligent Methods

Artificial intelligence is a new technology of research and development for simulation, extension and expansion of human's intelligence theory, method, and technology and application system. Artificial intelligence is a branch of computer science, it attempts to understand the essence of the intelligent, and produce a new way to human intelligence similar to react with intelligent machines, this domain research including robot, speech recognition, image recognition, Natural Language Processing and expert system etc. Since the birth of artificial intelligence, theory and technology has become increasingly sophisticated, the application of the field is also expanding, it can be envisaged that the future of artificial intelligence technology products, will be the human wisdom of the container". Artificial intelligence is the simulation of the information process of human consciousness and thinking. Artificial intelligence is not human intelligence, but can think like people, may also be more than human intelligence.

Artificial intelligence is some thinking process and intelligent behavior of the computer to simulate human (such as learning, reasoning, thinking, planning) discipline, including the principle, computer intelligent manufacturing is similar to the human brain intelligence of the computer, the computer can achieve a higher level of application. Artificial intelligence will be involved in computer science, psychology, philosophy, linguistics and other disciplines. It can be said that almost all of the natural science and social science disciplines, its scope has been far beyond the scope of computer science, artificial intelligence and scientific thinking is the relationship between practice and theory, artificial intelligence is in the thinking of scientific technology application level, is a branch of its application. From the point of view of thinking, artificial intelligence is not limited to logical thinking, to consider the image thinking and inspiration thinking in order to promote the breakthrough in the development of artificial intelligence, mathematics is often regarded as the basic science disciplines, mathematics has entered the language, thinking in the field of artificial intelligence, also must use mathematical tools, not only play a role in the standard of mathematical logic and fuzzy mathematics, mathematics into artificial intelligence, they will promote each other and develop faster.

Artificial Intelligence is to use artificial methods of machine to achieve its intelligent aim. Fields of artificial intelligence research covers the knowledge representation, expert systems, machine learning (learning, decision trees, rough-network learning), pattern recognition and artificial neural networks, etc. Machine learning main concentrates on how to enable computers with human-like ability on learning. Artificial decision making method is to apply the knowledge representation and thought process of the artificial intelligence into the decision-making theory, by introducing theory and method of management science, computer science and related disciplines, to analyze and compare, to make the right decisions for managers to provide intelligent help [3].

Due to its high fitting accuracy and fast modeling, artificial neural networks, in sports, has been initially applied. Current research interests include the competition modeling, diagnosis and prediction, for example, to predict the results of ball games, horse racing and winners in greyhound racing. With the development of computer technology, artificial neural networks show thus greater potential, at present, there are already some scholars using it for data mining and pattern recognition. A specific neural

network through training has achieved demands of a specific application areas, such as pattern recognition, data classification [4].

Technical, tactical assessment and prediction in volleyball match based on artificial intelligent methods. On the basis of diagnosis of techniques and tactics, try to assess and do research on volleyball match. It discusses about the significance, method, principle and operating procedure in assessment about techniques and tactics in a volleyball match. The evaluation process is divided into different assessment between players and a player's own assessment performed. The results show that: the technical and tactical evaluation methods based on the artificial nervous network are practical, fair. It is reasonable to distinguish respectively the level of technical and tactical strength of two sides in a game. On the basis of technical and tactical evaluation, preliminary volleyball match prediction can be achieved. Discussion of predicting meaning, classification and process. Studies on the combination forecasting method making use of the decision tree and artificial neural network, and use it to define the technical and tactical status for Elite Volleyball Players. From both the training time and the prediction accuracy, it compares, at the same time, the neural network forecasting with the combination predictive method. The predicted result of the back-tour match shows that the combination predictive one reaches a percentage of accuracy of 0.9285 which is approximate to the former, but it takes only 18.61% of time that the neural network forecasting needs. The neural network represents as follows in Fig. 2.

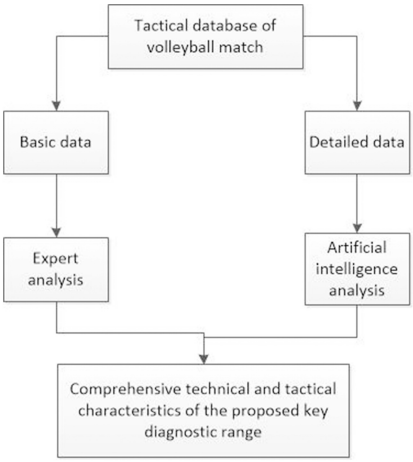

Fig. 2. Expression forms of neural network

2.3 Research of Sport Prediction

Sport prediction means that sports policy makers use some method to predict future trends in sports development to assist their decision-making. Sport prediction shows a growing need of the participation of mathematics and computer science. Volleyball-match diagnosis and assessment of technique and tactics can explore mature technology (see Fig. 3), models and methods in other fields. Such as: the use of computer software

Fig. 3. Volleyball match

can make the data collection becomes accurate, simple and fast. The use of database technology enables storing vast amounts of data in a relational form of data, which can provide a safe and stable basis for the establishment of the evaluation model. Using mathematical models can dig out a lot of hidden information that mathematical statistics can't find from the angle of data digging [5, 6].

Volleyball Technique and Tactics diagnosis and assessment should explore a method that can't measure the overall strength of the athletes, but also can learn how to grasp their individual capacity in each aspect [7, 8]. Current research goes in two directions: abstract and concrete. The former is for evaluating a match in a simple and efficient way, which requires that the index system is as simple as possible. The latter one concentrates on a more detailed evaluation on characteristics of the technical, tactical method during a match, while this also greatly brings down the efficiency of volleyball match assessment. In all, it requires researchers to find a balance between these two ways [9, 10].

The prediction error ρxy is generally presented as follows:

$$E\left(\frac{(X-E(X))(Y-E(Y))}{\sqrt{D(X)}\sqrt{D(Y)}}\right)=r_{XY} \tag{1}$$

The index for the prediction accuracy is definite deviation:

$$f_X(x)=\int_{-¥}^{+¥} f(x,y)dy=\int_{-¥}^{+¥} f_{X|Y}(x|y)f_Y(y)dy \tag{2}$$

The average square deviation MSE, it minimizes the counterbalance of deviation, in the form of:

$$f(x,y) = \frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} \times e^{-\frac{1}{2(1-\rho^2)}\left[\frac{(x-\mu_1)^2}{\sigma_1^2} - 2\rho\frac{(x-\mu_1)(y-\mu_2)}{\sigma_1\sigma_2} + \frac{(y-\mu_2)^2}{\sigma_2^2}\right]} \quad (3)$$

3 Results

The most important tactical behavior for men's volleyball players of being the third beat sights and the return of serve control. The tactical behavior most frequently applied female volleyball athletes is the formation of the balance of power after aggress and return of serve. The most important tactics is to grab and to send a stalemate balance. Compared with foreign athletes, Chinese men athletes appear stronger when controlling the ball and starting the ball; but the defense significance for foreign athletes is relatively larger; offensive tactics are still Chinese women volleyball players' main tactic.

4 Conclusion

In this study, artificial intelligence methods are analyzed in technical and tactical diagnosis, assessment and prediction during a game of volleyball. A comparative analysis is done in of artificial intelligence diagnostic methods. It improves the technical and tactical diagnostic method based on artificial neural network in volleyball game and realize the Elite Volleyball Players tactics diagnosis, which was helping the preparation for the competition and opponent analysis. Its results obtained recognition of both coaches and athletes. But there are still parts of studies that require further discussion.

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A Generic Model for the Application of Computer Aided Design in Environmental Art Design

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Abstract. Mankind has invented a million kinds of tools, one of the greatest inventions is electronic computer. The invention of the electronic computer is the human brain intelligence expansion and extension, it makes human more intelligent and it is the most advanced intelligent tools. And the computer aided design is emerged under such circumstance. Computer aided design as a main course of environmental art design in colleges and universities, On the one hand, the course for the goal of cultivating the students is the requirement of students can master skills of using computer aided design software very skilled, on the other hand also requires students to be able to according to the requirement of environmental art design course, can be a very good environment art design. Therefore, in the course of teaching, not only to make the students mastering software skills, but also for the classification of different types of software teaching, at the same time we should also improve the students' overall level of aesthetic culture and humane care of the plot.

Keywords: Computer aided design · Artificial intelligent expert decision-making · Human resources structure optimal management

1 Introduction

Computer-aided design (CAD) is a boost to the technology of enhanced design and skills of the designers which enable to translate their ideas and vision to reality. In the present technology-dependent world, the computer enabled design is more influential which cannot be ignored [1]. The current era is a transition period from the traditional manual design to the new innovative advanced computer design, where we stand high the technology ladder.

In the field of environment creative art and design, computer-aided design has reached its peak and serve as an indispensable tool [2]. Environmental art design is a big category which is very comprehensive. It refers to the space environment art engineering, planning, comprehensive planning art conception scheme, including the environment and facilities planning, space and decoration plans, shape and construction plan, material and color, lighting and lighting project planning, the use of functional and aesthetic plan etc. Its expression is also varied [3].

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Environmental art is the science of green, and creating harmony and lasting. City planning, city design, architectural design, interior design, sculpture and murals, architectural sketches all belong to the category of environmental art. It is closely related to people's life, production, work and leisure. With the improvement of people's living standard, people require a higher quality of all kinds of environmental art [4].

The enhanced feature is that it breaks the original design form and gives more realistic visual effects, rich drawing changes, accurate and efficient operations. Moreover it is convenient and easy for modification than traditional performance practices, where the advantages are well documented [5]. Because of these features the computer enabled drawings and diagram are more used everywhere such as specialized industries and fields, in the academic settings which draw innovative skills. The computer-aided design course has now become an important part in the fundamental curriculum system, and it is a necessary skill for environmental art design students to expertise in the appropriate software [6].

The methods of environmental art design are as follows. The first is that the expression of the drawings, in the type of expression of environmental design, graphics with its intuitive visual representation of visual material transfer function, in the first place of all the information transfer tool. Although the final result of environmental art design is a four-dimensional space entity contains time factor, and the design process is completed in the process of two-dimensional mapping [7]. Second is that the words and oral expression. Written text is also an important tool for the design of environmental art [8]. Graphics only through the analysis of the text interspersed in order to maximize the effectiveness of the play. At the same time, the expression of the text can go deep into the depth of the theory, in the planning stage of the design project, the design concept of the establishment phase and the design scheme of the examination and approval stage can be competent for the deepening of information communication requirements [9]. The last is a spatial model expression. Just because of the scale, materials, time, the financial relationship that we cannot make each program the same, and the small scale model is difficult to achieve a vivid effect. As soon as Computer Aided Design (CAI) applied in the environmental art design, the problems of all of the methods above began to be solved. And the environmental art design works become exquisite [10].

2 State of the Art

2.1 CAD Definition

CAD means to the computer-aided design, which takes the use of computer systems to help designers with graphic design work, and is now popularly named as CAD [11]. In all the disciplines of engineering and product design, the computers can help to design with more perfect with calculation, information processing, graphic design and other work (see Fig. 1).

Fig. 1. CAD works

2.2 CAD Development History

In the early design stages, engineers used hand drawings and sketches to translated the ideas with various practices, and then they gradually standardized and formed a set of drawing rules and then the engineering drawing becomes normalized [12]. But the varied challenging projects lead to difficulties with long cycle, low efficiency and work duplication, which eventually impeded the construction development. Hence the designers tried to the methods to enhance the work efficiency, free engineering and technical personnel from tedious, repetitive manual labor to give more focus on creative work [13].

The Computer Aided Design was created in 1960's, MIT initially advocated the interactive graphics program study, but due to hardware costs, only the General Motors Corporation and Boeing airlines utilized this interactive graphics system in US. In 1970's, it became increasingly deployed in U.S. industries [14]. The earlier CAD system was developed on mainframes or super-minicomputers which normally took hundreds of thousands or even millions of dollars; it was only used in large-scale industry sector, so design field was totally unmatchable [15]. Later, with the rapid development of microcomputers, the CAD comes to reality. With the support from high-performance microcomputers and various external devices, the system software for design made significant progress [16].

2.3 CAD Software Types Used in Environmental Art Design

CAD software has a powerful rendering, organizing and preserving the function of graphics, this powerful function can make the drawing of the drawings have a higher accuracy [17]. First of all, to understand the way to start and save graphics, drawing graphics, you can specify the type of unit to be used and other settings. You can also choose how to save work, including the save file. From scratch to create a new graphic, the method to quickly create a new graphic is from scratch, using the default graphics template file settings [18]. Use setup wizard to set up basic graphic settings. Using template files to create graphics, graphics template file contains the standard settings. Select one from the template file, or create a custom template file. Save graphics as well as the use of other Windows applications, save graphics

files in order to use the day after. You can set automatic save, backup files, and save only selected objects.

CAD Software Types Used in Environmental Art Design, as showed in Table 1.

Table 1. CAD software types used in environmental art design

Number	1	2	3	4	5	6
CAD software types	Photoshop	3DSMAX	MAYA	Autocad	CorelDraw	Lightcape

3 Methodology

The application methodology of computer aided design in environmental art design contains three steps, as shown in Table 2.

Table 2. The application methodology of CAD in environmental art design

Steps	The application methodology
1	The first level of computer graphics
2	The second level of computer graphics
3	The third level of computer graphics

3.1 The First Level of Computer Graphics

Computer aided design is divided into three levels, the first realm is the basic instruction only to master design software [19]. The main task at this stage of the students is a basic command master design software skilled, to the use of software tools menu and skilled, but in the current computer aided design in teaching, some teachers only pay attention to the mandatory operate the computer software, focused on the software parameters of memory and the master, ignore on the cultivation of aesthetic design software and creative use of, resulting in some students mistakenly believe that as long as the master of software, can do a good job of absurd ideas of design.

3.2 The Second Level of Computer Graphics

The second level that the students basic is mastering the main command design software, but also to create their own want according to the drawing needs to work, the software can harness. These teachers tend to have solid software skills in teaching, and to teach students to master and use the software [20]. But because teachers neglect the cultivation of students' aesthetic quality, neglect the student humanities nourishment, students lack the design aesthetic appreciation ability, not very good and distinguish the merits of design work, the student is a mere can use software drawing draftsman, not flexible to create outstanding designs, compared with the excellent designer required qualities are far. Therefore, it has also led to a

lot of students, although very skilled in the use of the software, but cannot always make a good design work.

3.3 The Third Level of Computer Graphics

The design of computer teaching ideas should be third kinds of state, that is to put the computer drawing skill and aesthetic combination design. Because the final purpose of computer software learning is to make the outstanding design projects, design software is only a tool for drawing it, like carrying a very advanced brush and paint is not always draw beautiful pictures, does not have any meaning. If the learning software and skilled, but do not create outstanding designs is futile. This requires teachers not only to teach students to master the use of the software, but also to let the students will be able to design knowledge before learning to in the learning process, such as color composition, layout design, font design and other disciplines knowledge interconnect. Set up the aesthetic design literacy, advanced gradually in the process of learning, and the beauty of personality in the formation of beautiful infiltration and infection, really achieve the ideal, that is technology, art, morally perfect unity.

4 Experiments

4.1 Case Study 1

The Digital City name suggests, is all kinds of information on the city; geographic location, customs, architecture, the letter from the economic level, etc. To digital means for processing, computer input devices, virtual reality technology restores the reality in the virtual environment in the face of the city. For example, Qatar soccer field (Fig. 2), before the commencement of construction of 3d Software design, show of elegance in the stadium perimeter of the park and public facilities related to the layout and structure makes clear the stadium. Easier for designers to adjust the details of a design, and through this digitized analog can intuitively feel the stadium environment day and night views.

Fig. 2. Qatar soccer field

4.2 Case Study 2

The Virtual Building name suggests is a kind of virtual building out, a fact that does not exist in the objective world. The building is based on the person's intention to create a virtual world in the building. Man deploys the virtual building scene. The tour is very contemporary fashion in the field, the prospect is very beautiful; this industry needs a virtual scene. Industries have come in handy, such as a virtual battlefield demonstration, a virtual combat simulation, virtual game scenes, etc., contributed to the birth of a new art form (see Fig. 3).

Fig. 3. Qatar soccer field

The modeling tool provided by 3DSMAX includes basic modeling tools and advanced modeling tools. The basic modeling tool provides a cube, sphere, a sphere, a cylinder, a circular tube, a circular ring, a cone and a polygon. Advanced modeling tools can be made out of the mountains, water, ripples, waves and particles and irregular shapes, such as: human, plants etc. The 3D can be twisted, bent, zoom, swing, angle deformation, carving and cone etc.

In the field of environmental art design, Studio Max 3D is mainly used for the production of the interior and exterior of the building and environmental animation production. In three-dimensional form to show the effect of building and indoor and outdoor decoration, not only quick and convenient, but also the full preview of the effect of the various angles of the building, and the perspective is also accurate (see Fig. 4).

Fig. 4. Computer aided design environmental art works

5 Conclusion

The application of computer assistance design in the environment art teaching, is not only a technical problem, from the overall design should be an all-round care literacy of students. In the process of teaching, teachers should try to let students understand the software is only to master the technology, technology in order to make the design, technical proficiency and mastery of the design level is not completely proportional, in the process of learning software, not only need to master the software itself should also operation order. The other design disciplines of basic knowledge in computer design, while the students in the learning process should pay attention to strengthening their own aesthetic culture, and humanistic feelings, can truly make software for their own use, it can be through the software design, excellent design works of ingenious design, elegant style.

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The Research on the Analysis of Characteristics and Performance of ICAI for Table Tennis Training

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Abstract. With the continuous development of science and technology, artificial intelligence technology and computer-aided instructional technology have become an indispensable part in the process of sports training. How to use computer-aided instruction system for better table tennis training has been a hotspot in relevant research institutions at home and abroad. On that basis, this paper analyzes the characteristics and performance of ICAI for table tennis training. After briefly introducing the basic theory of artificial intelligence and computer-aided technology theory, this paper uses neural network and decision tree method to obtain more stable tactics diagnostic studies and improves the methods of table tennis training tactics based on artificial neural network. And through in-depth research on the artificial neural network technology, this paper uses computer aided teaching software to guide and evaluate tennis practical training. Then, use the relevant algorithm to obtain the indexes and quantify the measurement results after introducing artificial intelligence techniques into the computer aided teaching system. The results show that computer aided teaching system for table tennis training based on artificial intelligence can be more effective tactical training and teaching activities to enhance the reliability and practicality of the teaching system.

Keywords: Table tennis training · Computational intelligence · Intelligent teaching · Fuzzy sets

1 Introduction

Computer-aided teaching system has become an important pillar of university sports development in the new century. Computer-assisted instruction, which centers on artificial intelligence technology and computer technology, has attracted wide attention in the field of sports education and has added new blood into college physical education. Table tennis training computer aided teaching system based on artificial intelligence can effectively solve the tactical difficulties and other issues of motion analysis in the table tennis competitions and training process. In addition to the process of table tennis sports teaching, the system can be widely applied to other confrontational sports projects.

The earliest table tennis tactics diagnostic and assessment studies were in the 1980s. The researches were mainly about the analysis of certain kinds of specific skills and tactical indicators which coach taught students. In 1990, WU Huanqun did the

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research of "sub-assessment method", which distinguished different levels of tactics and different athletes and differently guide the evaluation [1]. In 1996, Li Jinliang studied "10 indicators, assessment method" and this study was similar to the research done by WU Huanqun and did the detailed division and induction on the basis of "sub-assessment method" [2]. In 2008, through the research of performing association rules and sequential patterns, Yu Lijuan, Zhang Hui and others systematically discussed the pros and cons of a table tennis match during batting sequence and explored the associated properties of serving ball round and picking ball round [3].

The rapid development of computer technology also promotes the development of computer-assisted instruction. The changes in the field of education continually affect the process of the contemporary education system. Computer aided teaching in universities continues towards a more advanced direction. From 1958 to 1975, computer-aided teaching philosophy appeared to rise and is constantly being improved with the upgrading of computer technology [4]. In 1958, IBM developed the world's first computer-assisted teaching system. Its function was very simple and it just generated a binary sequence or production exercises via computer and transferred to the printer, but it is a symbol of the emergence of this initial attempt computers in education [5]. Subsequently, researchers in the University of Illinois developed the world's first computer-assisted teaching system with a touch screen. The system had a plurality of terminals, so students could answer questions and learn via the touch screen [6]. In the mid-eighties, the microcomputer got a lot of popularity, US universities promoted the computer to carry out the boom, of which the most widely used was computer-aided instruction. It greatly enriched the school teaching form [7]. In the late twentieth century, with the development of computer technology and network technology, the information age makes computer-assisted instruction has richer functionality and more widely used [8].

There are still some problems in the current table tennis training computer assisted instruction system, such as the intelligence degree is not enough and the equipment is not concentrated. On this basis, this paper uses the method of exploratory research, artificial neural networks and decision tree theory to design the computer assisted instruction system based on artificial intelligence for table tennis training and to verify and analyze the system's characteristics.

The rest of the paper is organized as follows. Section 2 briefly introduces the related knowledge of artificial intelligence technology and the theory of artificial neural network. Section 3 studies fuzzy mathematics and discusses the establishment of technology system and tactical system. Section 4 analyzes the characteristics and performance of ICAI for table tennis training. Section 5 is the conclusion.

2 State of the Art

2.1 Artificial Intelligence

Artificial intelligence technology is called AI for short. In 1956, AI was proposed as a discipline by McCarthy, so McCarthy is known as "the father of artificial intelligence". At that time, McCarthy had a meeting with many scientists in many fields in an

American university. He collaborated with these mathematicians, computer scientists, psychologists and neurophysiologists to put forward it. AI is a comprehensive, interdisciplinary, involving a very wide range, which includes computer science, information science, neurology, philosophy, linguistics and other basic discipline and combines a lot of researches to gradually develop [9]. It is thanks to this, until now, there is not with a precise definition of artificial intelligence and no one can give a unified presentation. Because in different disciplines, researchers in different disciplines look upon artificial intelligence from a different perspective and they have different understanding about this technology. Broadly speaking, artificial intelligence technology is about the creation of intelligent human behavior and this intelligent behavior generally includes many behaviors under different circumstances, such as perception, learning, reasoning, communication, and in complex environments [10]. Moreover, from an engineering perspective, the aim of artificial intelligence is to make machines have human intelligence-related functions, which are: judgment, reasoning, perception, thinking and so on. To achieve this goal is by artificial intelligence. The result reflects human's wisdom and thinking and the way reflecting is the machine [11].

2.2 Artificial Neural Networks and Decision Tree

The decision tree is a data structure. Its main role is classification and prediction. The structure of tree data is composed of nodes. These nodes are arranged from the top down, one test on an attribute, which is a middle node, the result represents a side on behalf of the property once classified and the classification result is a leaf node, so the decision tree is a combination of a set of decision rules [12].

In the process of establishing decision tree, the founders can't clear the relevant background knowledge and the result of the operation, easy to understand and adept at handling qualitative data formed by the subjective judgment of the data within a certain size modeling efficiency and accuracy is high. Based on the above characteristics, the method has been successfully applied to classified data sets preprocessing, target sets, data mining, forecasting and decision-making [13].

In the field of sports and education, the artificial neural network technology has been applied widely, because the technology has high accuracy and fast speed [14]. The current research fields include the modeling competition, diagnostic and forecasting, such as predicting the results of ball games, the ranking of horse racing and the winners of greyhound race. Through training, a neural network model can meet the application in specific areas, such as the field of pattern recognition and data classification. With the development of computer technology, artificial neural networks have made great progress and improvement, showing a greater development potential. Nowadays, data mining and pattern recognition can already see the signs of neural network technology [15].

3 Methodology

3.1 Fuzzy Mathematical Basis

Assume X represents the collection of objects, called a domain. For a subset A of X, we can use its characteristic function to express it, given:

$$\mu_A(x) = \begin{cases} 1 \\ 0 \end{cases} \tag{1}$$

Wherein:

$$\bar{A} = U - A \tag{2}$$

μ_A is a function which is defined in X and its value range is from 0 to 1. It is called the characteristic function of subset A. The elements in subset A have the same characteristics and these characteristics can be expressed by μ_A. For $x \in X$, if x is an element of A, then $\mu_A(x) = 1$. On the contrary, if $\mu_A(x) = 0$, which means that x is not an element of A. Therefore, we can define the fuzzy subset (also called fuzzy set) as:

In the domain of discourse X, for any $x \in X$, if there is a real function $\mu_A(x)$ expressed by the Formula (3) corresponding it.

$$\mu_A : X \to [0, 1] \tag{3}$$

$$X \to \mu_A(x) \tag{4}$$

If the element X can meet the conditions in Formulas (3) and (4), then the all set of the element can be called the fuzzy subset A of X. For $x \in X$, the membership function of A is μ_A. μ_A is called the degree of membership of fuzzy subset A.

The absolute representation of fuzzy set can be shown as the following figure. In the figure, X represents the domain of discourse and it is expressed by rectangle. The fuzzy subset A is expressed by dotted circle, which defines the periphery of the subset. In fuzzy function, the function μ_A is specific and the fuzzy subset A is abstract. Therefore, the fuzzy subset A in the domain of discourse X can only express by function μ_A. From the figure and definition, we can see that the degree of membership of x to fuzzy subset A is reflected by the value of $\mu_A(x)$ in the range of [0, 1]. If $\mu_A(x) = 0$, then x does not totally belong to A; if $\mu_A(x) = 1$, then x totally belongs to A; if $0 < \mu_A(x) < 1$, then x belongs to A to the extent of $\mu_A(x)$. Absolutely, when the value domain of $\mu_A(x) = 1$ is {0, 1}, then fuzzy subset A is the common set. So, the fuzzy set and common set have certain correlation. Strictly speaking, common set is the fuzzy set, but the form of common set is special. Besides, after promotion, the common set may become fuzzy set (Fig. 1).

There are two points which need to note for fuzzy sets. The first one is the domain X and the second one is the shape of the membership function. Domain X is a table set of fuzzy sets, which can be defined as different fuzzy subsets of the table set according to different requirements and situations. Similarly, depending on the different problems, the specific shape of the membership function will be different.

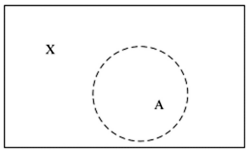

Fig. 1. Fuzzy subsets

If the table set is the finite set, then the fuzzy subset A of X can be expressed as:

$$A = \sum_{i=1}^{n} \frac{\mu_A(x_i)}{x_i} \tag{5}$$

If the table set is the infinite set, then the fuzzy subset A of X can be expressed as:

$$A = \int_e \frac{\mu_A(x)}{x} \tag{6}$$

3.2 The Establishment of Technology System and Tactical System

After statistics and analysis, we can find that in the process of game, fast-break loop technology, picking technology and push-and-block technology are more commonly used in the game. In the eighty percent of the time, these are common technical action to complete the game. The most commonly used technology is fast-break loop technology, reaching more than 20%. And the fast-break loop technology can be divided into two categories to distinguish the different characteristics and indexes in two cases. The indicator system is as shown in Table 1.

Table 1. Technical system of table tennis match

First order index	Two level index		
Serve	Drop shot	Half out of the pool	Long
Forehand loop	Forehand long	Long road	Backhand ball
Backhand loop	Forehand long	Long road	Backhand ball
Pick up	Forehand	middle	Backhand

Table tennis tactical system includes related content of match timing and classification of tactical behavior. Wherein, tactical behavior classification refers to the four stages: the first stage is the offensive, the second stage is the defense, the third stage is controlled, and the fourth stage is the balance of power. The timing of the game is mainly three timing sections: The first section is grabbed, the second segment is connected, and the third segment is the timing stalemate segment. The combination of game timing and tactical behavior is shown as Table 2. Wherein, aggress includes

Table 2. The tactical system of table tennis match

Match time	Serving section	Receiving section	Stalemate
Index	Serve attack	Receiving attack	Stalemate attack
	Serve control	Sending and receiving control	Stalemate control
	Serving defense	Sending and receiving defense	The stalemate defense
		Then the balance of power	The balance of power

serve and a third plate, then aggress includes the return of serve and a fourth plate, stalemate includes the five rounds after serving plate and serve receive after six rounds.

4 Analysis and Discussion

In the course of actual training and table tennis game, the state of the athletes is not always stable. When they face different situations and the opponent, the state of the players has ups and downs, so their competitive state will be significantly different. How to know and appropriate training becomes a very critical issue, they should make the specific training arrangements for good, normal, poor state level to grasp different states under different circumstances. We should be aware of the game situation and the environment and have a more objective understanding of the laws of the game.

Use diagnostic methods based on neural networks, but for the diagnosis of personality characteristics, according to the different competitive state, it should be divided into three cases of excellent, ordinary and poor. Figure 2 is the table tennis match data acquisition and analysis platform.

Fig. 2. Table tennis matches data acquisition and analysis platform

The experiment uses the Levenberg-Marquardt algorithm to collect and analyze match data and randomly selects for 10 games in all 50 games. Then this paper uses a bomb back algorithm to determine the training time and accuracy, which is shown as Figs. 3 and 4. As can be seen, the number of nodes in the hidden layer and using an algorithm to train the network accuracy.

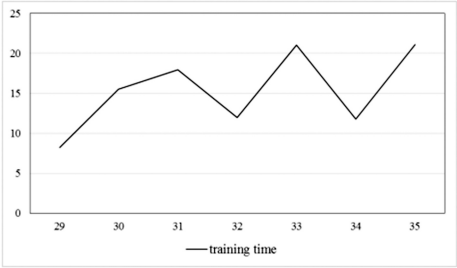

Fig. 3. Training time of different training function nodes

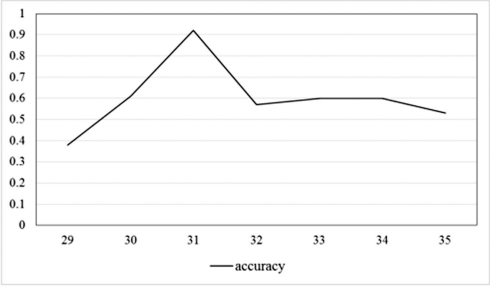

Fig. 4. The accuracy of different training function nodes

After training, the validity and accuracy of the model is tested. Table tennis players of Chinese and foreign technical and tactical overall technical and tactical characteristics of men and women incremental diagnostic function to change the value of the technical and tactical methods, Figs. 5, 6 and 7 are the overall technical condition, diagnosis, three figures sequentially display the influence of the scoring rate of 24 technologies on game-winning, the influence of 24 usages on the game-winning as well as the influence of six technologies (forehand loop drive, backhand loop drive, pick hit, split long, short swing, push-and-block) on the game.

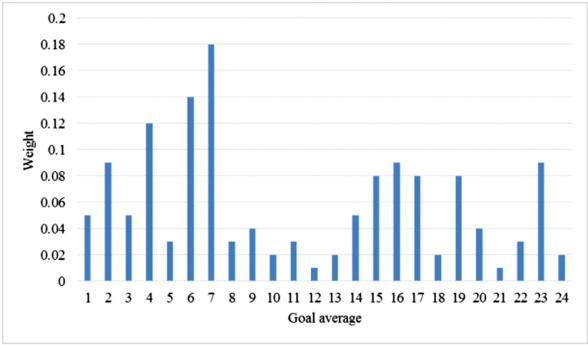

Fig. 5. Score rate of 24 techniques

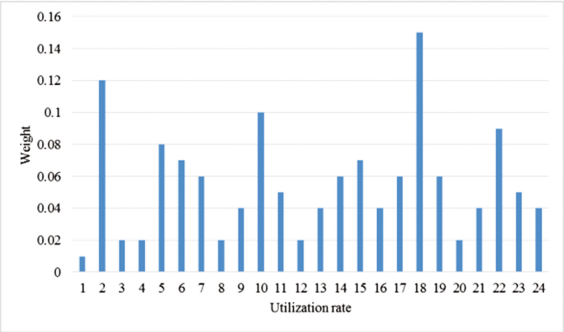

Fig. 6. 24 item usage

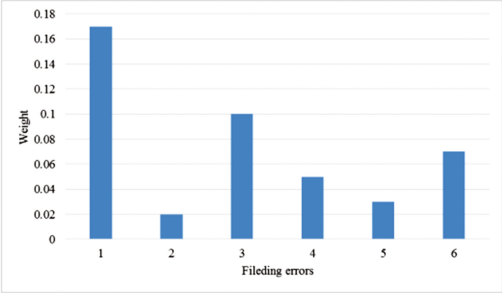

Fig. 7. Six major technical failure rate

From the above experiment, we can see that tree data structure and an artificial neural network algorithm have a good effect on table tennis match technical and tactical diagnostic procedures, in which the decision tree and rough set reduction method based on the properties of the classification ability to distinguish each the importance of indicators, artificial neural network algorithm which also involves a number of sociological research methods. Use the situation of the sample data before and after the change to test the technical and tactical features complete diagnosis. In the three methods, the selection of training sample size has a greater impact on the diagnostic results, especially for the diagnostic results of the rough set method.

5 Conclusion

In the era of rapid development of science and technology, in order to better use artificial intelligence and computer-aided instructional technology to serve for sports teaching and promote the research on computer aided system for table tennis training, this paper analyzes the shortcomings of traditional table tennis assisted instruction system. And then this paper does thorough research and analysis for the features and performance of table tennis training computer-aided teaching system based on artificial

intelligence. On the basis of the in-depth understanding of the relevant technology, how to more effectively carry out the work of college physical education CAI, the decision tree algorithm and data structure of neural networks are proposed to solve the teaching problem of low efficiency in the teaching process of computer-aided system. Analyze the experimental data through the experiments, it can prove that in the aspects of teaching efficiency and assist practical, the system has obvious advantages compared with other computer-aided instruction systems. The design of table tennis training computer aided instruction based on artificial intelligence and the analysis of the characteristics and performance of the overall system is of great help for the improvement of the tactics consistency and technical stability in the process of table tennis training in colleges and universities. And it also has great significance for the development of PE Teaching. Of course, the development of technology will propose higher requirements for the instantaneity of the teaching system and the improvement of teaching process, so this study still needs improvement and further research.

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Research on Effect Evaluation of Physical Education Teaching Based on Artificial Intelligence Expert Decision Making System

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Abstract. Teaching Result Evaluation in physical education plays an extremely important role in the link of the teaching of Physical Education. The development is accompanied with the development of evaluation and evaluation of education. The principle, data, mathematical model and human computer interaction model were used in the evaluation of Physical Education teaching according to artificial intelligence expert decision system, and the index system of evaluation of physical education teaching work was constructed, based on this, the sports evaluation and monitoring system with functions of diagnostic evaluation, data statistics and assistant decision making was studied in this paper, then the math model was built by calling a variety of sports teaching information resources and a large number of analytical tools, and the simulation process of decision making and the environment of analysis and execution were provided. The results show that the evaluation results of physical education teaching effect based on artificial intelligence expert decision-making system can provide theoretical basis for decision-making and evaluation of relevant competent departments, which plays a positive role in promoting the reform of physical education and improving the quality of physical education.

Keywords: Artificial intelligence · Expert system · Physical education

1 Introduction

With the continuous development and deepening of the reform of physical education teaching, the effect of physical education has been paid more and more attention and the evaluation method used is more and more reasonable and scientific. With the development of science and technology, the idea based on artificial intelligence expert decision system to study the effect of physical education teaching evaluation has become the trend of development research. Derry discusses the importance of scientific research achievement evaluation standard for physical education teaching, analyzed the current situation and problems of the evaluation criteria of the sports scientific research achievements in various colleges and universities and puts forward the principle of making the scientific evaluation standard of college sports scientific research achievement [1]. Mellit carried out deep exploration and analysis of a variety of factors in the field of

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sports science and research in the method of psychology and management. However, it is found that the researchers give a very big evaluation of the distance to each factor. They are not optimistic about the evaluation of human resources and given a series of suggestions and solutions [2]. Piltan investigated, understood and analyzed the characteristics of the research results of sports research, and the advantages and disadvantages of various evaluation methods are analyzed and explored in order to better evaluate the current methods of teaching evaluation of Physical Education [3]. How to set up the evaluation index system of sports teaching achievement is an important problem to be solved at present. Piltan considered the principle of an evaluation index system of physical education teaching achievement should be followed. He tried to illustrate the importance of the theory by means of an example, at the same time and the application of physical education teaching results in the synthesis evaluation based on Artificial Intelligence [4]. Research on the evaluation system of sports scientific research in Colleges and universities is not much. For example, Wang Sum up some experience of teaching evaluation in Colleges and Universities through investigation and study. He put forward the university physical education teachers work assessment, quantitative management methods and research work to quantify the assessment methods and incentives from three aspects of the practice of scientific research of physical education teachers in Colleges and Universities, content range of quantitative assessment of scientific research work, teacher personal annual scientific research workload evaluation scoring method and minimum annual quota standard for scientific research [5]. Bravo analyzed and expounded the reality, rationality and feasibility of the implementation of physical education teaching evaluation in Colleges and universities respectively from the university to carry out the motivation of sports teaching measurement, evaluation, analysis, problems should be paid attention to in the teaching work particularity, sports teaching measurement and evaluation process should follow the principles and the sports scientific measurement and evaluation process. He also obtained the conclusion that only by gradually developing and improving the measurement, evaluation work can we play the enthusiasm and creativity of teachers actively engaged in scientific research and took efforts to improve the level of physical education in Colleges and Universities [6].

This paper studies the effect of physical education teaching evaluation and monitoring system based on the expert decision system of artificial intelligence, which provides a flexible and convenient platform for the evaluation and monitoring of physical education in Colleges and universities. The development status of the expert decision system of artificial intelligence is discussed in the second section. In the third section, the development environment, the overall structure design, the knowledge database design and the examination function design of the physical education teaching effect evaluation based on the artificial intelligence expert decision system are studied and the results of the design can be evaluated for the effect of physical education teaching. The results of the evaluation of the effect of artificial intelligence expert decision making system for physical education teaching are discussed in the fourth section. At the end of the fifth section, the research process and results are summarized.

2 Background

The introduction of artificial intelligence makes expert decision-making system is no longer a separate subject, but a variety of disciplines such as management and computer science and is a new cross discipline or the edge of the subject. The system is mainly composed of 6 parts, including knowledge base, integrated database, reasoning machine, man-machine interface, knowledge acquisition procedures as well as the interpretation of the program. The system is developed on the basis of the rule expert system, which solved practical problems in the field of development in the method of reasoning based on rule expert system and a large amount of knowledge through a specific computer program. The main modules of the expert decision-making system are the knowledge base, the integrated database, the reasoning machine and the man-machine interface at present. Interpretation and knowledge acquisition program are the two modules in the system of expert decision making [7]. The function of the integrated database is to store all the information related to the problem solving in the structure of expert decision making system. First of all, the interpretation process of the user's questions was analyzed and the current state of the system such as solving process and so on to make a description on this basis. As a result, the user can clearly understand how the system is to solve the problem and it also improved the credibility of the results of the user to the system. Knowledge database is a collection of empirical knowledge of all kinds of experts. The inference engine needs to be assisted by relevant control strategies in the work so that screen and identify the useful information in the expert database, reasoning and analysis of the rules. The knowledge base is a kind of small scale mapping for expert database, which will replace some of the work of the knowledge engineer, and achieves automatic acquisition of knowledge and information, autonomous learning and improving the knowledge base. The input information of the system is obtained through the man-machine interface, and is accepted by the internal finally. The information needed by the user is translated into a form that is easy to understand for the user and output through the system [8].

The expert decision making system based on artificial intelligence has been applied in many fields. It can predict the geological condition, measure the mineral reserves, and determine the location of the mining. It can also assist in the treatment of patients and diagnosis of disease. It can also be calculated to determine more reasonable cross parent object and arrange plan according to market demand and production process data [9]. The system has been widely used in various fields, and has done a lot of research [10].

3 Methodology

3.1 Evaluation and Development Environment of Physical Education Teaching Effect Based on Artificial Intelligence Expert Decision Making System

The design and development of the expert decision system can usually choose three paths. The first is the tools used to access to knowledge, such as knowledge acquisition system. The second is programming language using LISP or PROLOG. The third is an expert system development tool using CLIPS or M.1 [11].

Development environment and operating environment formed the expert decision-making system development tools. The development environment is usually composed of knowledge editor, compiler module, knowledge base query, maintenance module, database query, maintenance module, knowledge base and real-time database. The composition of the operating environment, mainly includes six parts, which are reasoning machine, explanation mechanism, human-computer interaction, knowledge base, and real-time database. The development environment and the running environment, both contain the knowledge base and the real time database. They are input in the development environment and then are provided to the operational environment [12]. Expert system, development tools have the following characteristics which can be seen from the structure of the expert decision making system development tool: First of all, the development environment and operating environment constitute the most important two parts of the development tool. The reasoning mechanism and the explanation mechanism are well prepared in advance. To support the operation of expert decision making system is running environment. The second is that the language used by the development tool is the language of the special development expert decision making system, including the tool operating language which can use the function of the operating environment in the environment of development and the compiler identification language to complete the completion from external knowledge to the internal knowledge [13].

3.2 The Overall Design of Physical Education Teaching Effect Evaluation Based on Artificial Intelligence Expert Decision Making System

Artificial intelligence expert decision making system is also a kind of computer application system. Therefore, generally speaking, the development process of physical education teaching effect evaluation based on artificial intelligence expert decision system should follow the steps and principles of software engineering, That is to say that it also goes through the system analysis, system design, and several other stages of the work. The design of the system architecture can be as shown in Fig. 1.

3.3 Design of Knowledge Database for the Evaluation of Physical Education Teaching Effect Based on Artificial Intelligence Expert Decision Making System

Knowledge database is the core of the evaluation of the physical education teaching effect based on artificial intelligence expert decision making system. The quality of knowledge database is directly related to the performance and efficiency of the whole system. Therefore, knowledge database involves the organization and management of knowledge. Knowledge organization determines the structure of knowledge databases. Knowledge management includes the establishment of knowledge database, delete, reorganization and maintenance and knowledge entry, query, update as well as optimization. It also includes the knowledge of integrity, consistency, redundancy checks and security protection and other aspects of the work. Knowledge management is responsible for the knowledge database management system [14].

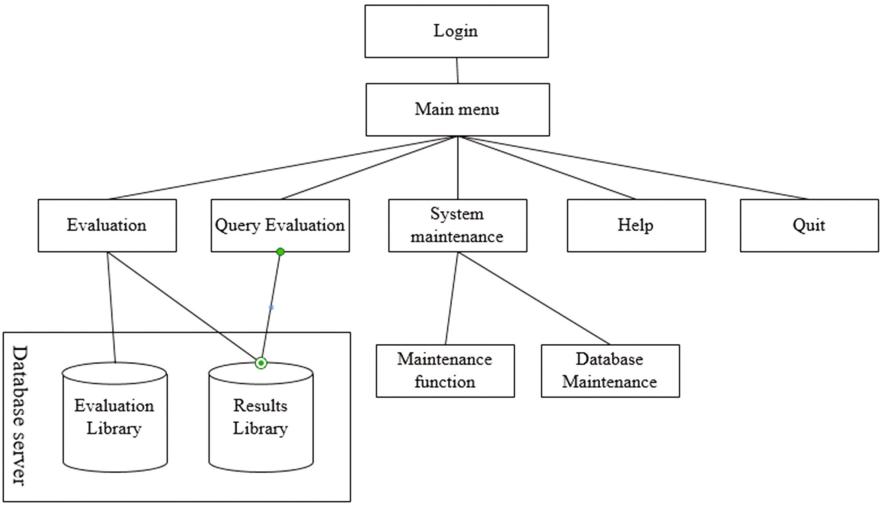

Fig. 1. The overall structure of decision system

Knowledge database design is the structure of the design knowledge database, which is the organizational form of knowledge. Knowledge databases involved in expert systems (or knowledge engineering) evaluated the original index attribute value of knowledge database is stored and different evaluation objects. The structured index attribute value of the evaluation object of the index system is stored in the standard database, and the database information about the database dictionary main storage structure was organized in accordance with the provisions [15]. The following on the evaluation system of some of the main database tables are described.

The knowledge database user login is mainly the user name and password that need to be authenticated. Data table also provides a number of users can contact, the user's contact including email address and contact phone number. The User login database table was shown in Table 1.

Table 1. Member information table

Field name	Data type	Length	Allow for null
ID	Int	4	N
Admin Name	Varchar	200	N
Password	Varchar	200	N
E-mail	Varchar	20	Y
Tel	Int	20	Y

Knowledge database evaluation category master table storage the result of the evaluation of the teaching effect of physical education and the data of the analysis results. The main table of evaluation categories includes mainly the teaching quality of physical education, physical education teachers' professional level, the level of physical training,

the physical fitness of college students and the standard of physical education of college students. The main table of the evaluation category is shown in Table 2.

Table 2. Evaluation type sheet

Field name	Data type	Length	Allow for null
Teaching quality	Varchar	100	N
Physical education teacher professional level	Varchar	100	N
Sport training	Varchar	100	N
Students' physique	Varchar	100	N
Students Sports Qualification Standards	Varchar	100	N

3.4 The Examination Function Design of the Knowledge Database of the Sports Teaching Effect Evaluation Based on the Artificial Intelligence Expert Decision System

Knowledge database checking function includes knowledge consistency, integrity and redundancy.

The consistency of knowledge is that knowledge in the knowledge base must be compatible, that is to say no contradiction. The so-called integrity refers to the knowledge of the constraints, which was called integrity constraints. The so-called redundancy is redundant. Redundancy check is to check whether there is redundancy in the knowledge base. That is to say that there is no redundancy. Redundant performance is a phenomena that repeated, including and loop.

4 Evaluation

The running stage of the evaluation of the effect of physical education teaching based on artificial intelligence expert decision system is the first experience of the trial operation of the expert decision evaluation system, as shown in Fig. 2. The trial operation of knowledge database is the application of the evaluation of physical education teaching effect based on the expert decision system of artificial intelligence, and carries out the implementation of various operations to knowledge database such as add, modify, delete and query. It is necessary to evaluate the trial operation stage, according to the data test so as to observe whether it meets the user's requirements. If it is not able to meet the requirements, you must modify, adjust and test the database until it reaches the design requirements.

Fig. 2. Test run

User evaluation of "very satisfied" to the effect of physical education teaching based on the artificial intelligence expert decision making systems accounted for 54%, the students who hold this attitude that "Feeling can also" accounted for 35%, the students who hold this attitude that "Don't like" accounted for 11% according to the survey, as shown in Fig. 3. It is obvious that the users are recognized to the effective evaluation of physical education teaching based on artificial intelligence expert decision making system.

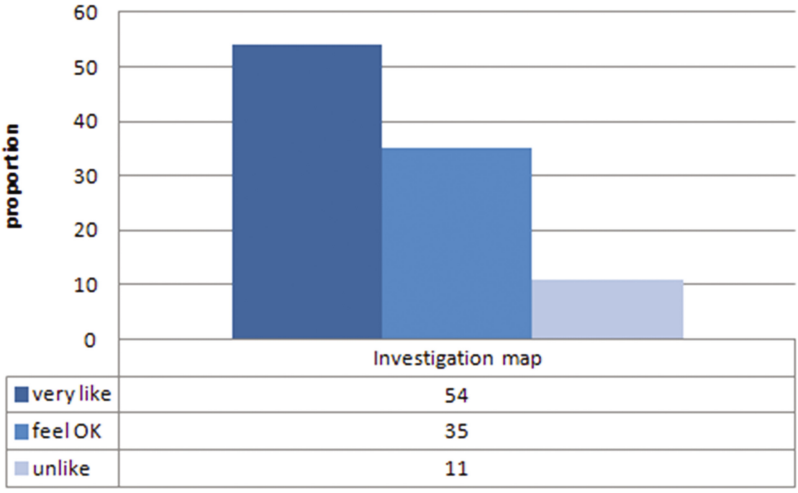

Fig. 3. Investigation map

Knowledge database can enter the formal operation stage after the successful trial operation of evaluation knowledge database of physical education teaching effect based on artificial intelligence expert decision making system, which also marks the development of the evaluation of the physical education teaching effect based on the expert decision system of artificial intelligence. As shown in Fig. 4, it is the login screen of the teaching effectiveness evaluation of the physical education teaching effect based on the

Fig. 4. Login display

artificial intelligence expert decision system. Users enter the user name and password to log on to the system and carry out evaluation.

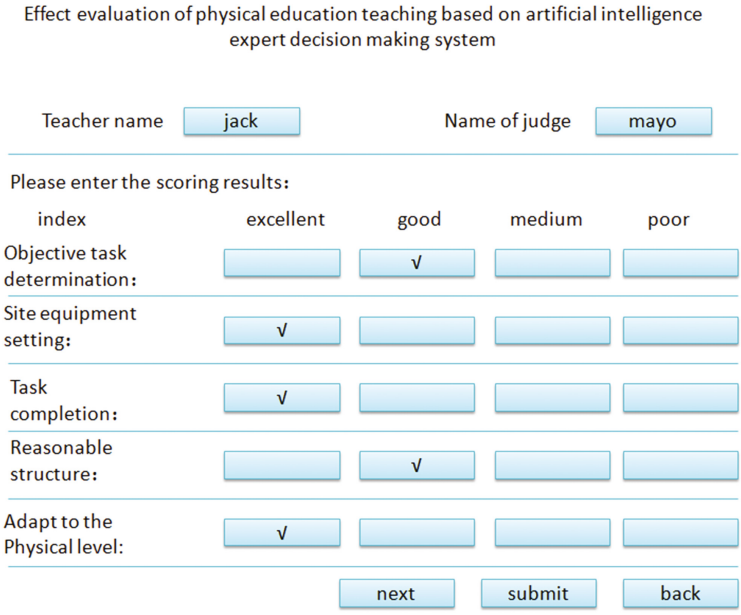

Fig. 5. Evaluation Interface

An evaluation system of physical education teaching effect based on artificial intelligence expert decision making system can carry out customized analysis and evaluation according to the user's specific requirements, to call different evaluation models based on different knowledge database. It outputs the result of evaluation and automatically save the data so that it is easy to query and statistics. As shown in Figs. 5 and 6, it is the evaluation interface of physical education teaching effect based on artificial intelligence expert decision making system, and the user can select the appropriate assessment level according to the evaluation criteria.

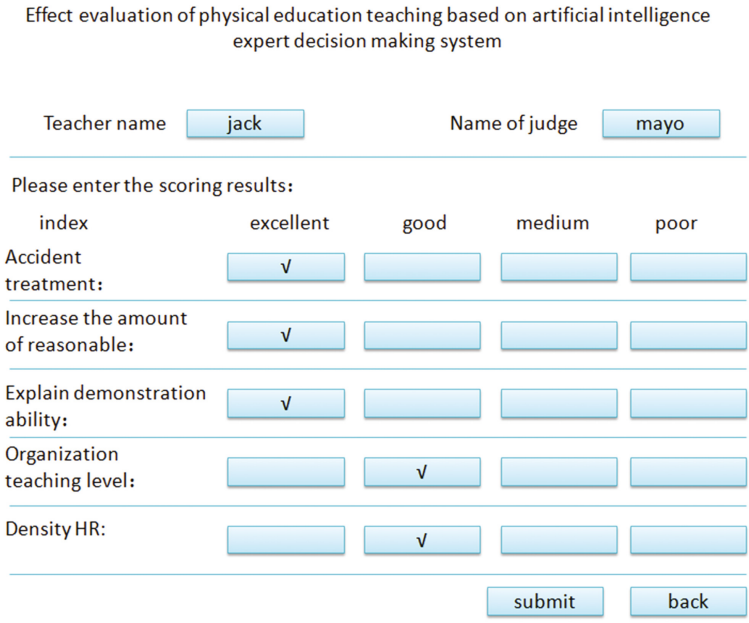

Fig. 6. Evaluation Interface

5 Conclusions

To realize the function module of expert decision making system using artificial intelligence and to evaluate the effect of Physical Education Teaching using these characteristics that distributed memory, self-learning, associative memory and fault tolerance of artificial intelligence. The PE teaching effect evaluation and monitoring system researched tests the existing hardware and software systems combined with the commonly used methods and basic steps in software testing until the system is measured to meet the overall objective. The PE teaching evaluation system has completed the design and implementation of the overall framework structure and be able to assess the value of the evaluation system. It can also carry out Multi - directional and multi - level comparable to the object based on their own needs, And produce the corresponding evaluation effect statistical chart so that to carry out qualitative and quantitative analysis.

It also needs to study and improve the monitoring system of physical education teaching effect evaluation due to sports teaching effect evaluation and monitoring system involved in a wide range so as to achieve the purpose that assistant management decision and improving the effect of Physical Education teaching.

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Intelligent Neurocomputing

Text Detection with Deep Neural Network

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Abstract. Text detection in natural scenes is still a challenging task in computer vision. In this paper, we developed a novel deep neural network ICPT-CNN. Within the ICPT-CNN structure, features learning and text/non-text classification are integrated into one complete process, which leads to an effective model for text detection. We use the local response normalization and Leaky ReLU function to improve the network learning ability. The proposed method is evaluated on standard benchmarks and achieves performance comparable to state-of-the-art. F-scores of our method improved 1% under the condition of keeping the same precision with other advanced methods. Further experiments on character recognition demonstrate the increase in representational power of our ICPT-CNN.

Keywords: Text detection · Deep neural network · Feature learning

1 Introduction

Driven by a variety of applications, scene text detection and recognition have become important research topics in computer vision. To efficiently read text from image, the majority of methods follows two-step process: text detection and text recognition [1]. Extracting text from natural scenes is a critical prerequisite for further text recognition. Therefore, the accuracy of text detection affects the performance of imaging high-level visual tasks. In addition, texts in images contain rich and valuable information, which can be exploited in content-based retrieval and image understanding. Text detection has been considered in many studies and considerable progress has been achieved in recent years [2–15].

However, detecting text in uncontrolled conditions is still difficult. Text in images can be in variation of font size and style, different alignment and orientation. Texts can be distorted by strong lightings, blurring and occlusion. Furthermore, the background of natural scenes is complicated, including a number of text-like objects such as bricks and windows. Due to these factors, text detection in natural scenes is a challenging problem in computer vision.

In recent years, deep neural network has been responsible for major breakthrough in various computer vision tasks, especially image classification and object recognition. The connectivity pattern between neurons in the network is inspired by the organization of the animal visual cortex. Its multilayer perceptrons structure only needs minimal amounts of preprocessing, and has strong ability of feature representation.

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Despite the attractive qualities of deep neural network, its capacity can be different by varying its depth and breadth. For different applications, reasonable network structures and training techniques will have a great impact on network performance. Our study is focused on training more powerful deep neural network, to obtain discriminative character features. Using deep learning features, we are able to use simple, non-maximal suppression to locate the text. We first introduce the architecture of ICPT-CNN (CNN with improved convolution post-processing technology) and the training process. Then we described the improved technology used in ICPT-CNN network. Finally, a complete detection algorithm based on ICPT-CNN is presented.

The rest of this paper is organized as follows. Section 2 reviewed the recently published literature. A novel deep neural network ICPT-CNN is described in Sect. 3. Section 4 describes the proposed text detection method in detail. In Sect. 5 the experimental results on ICDAR 2005 data set is presented. The paper concludes in Sect. 6.

2 Related Work

Existing methods proposed for text detection in natural scene images can be broadly categorized into two groups: connected component (CC) methods and sliding window methods.

Connected component methods separate text and non-text pixels by running a fast low-level filter, group text pixels to construct character candidates from images by connected component analysis. Stroke width transforms (SWT) and maximally stable extremal regions (MSERs) are two representatives connected component based methods applied in scene text detection. Epshtein et al. [2] proposed the concept of SWT, and used the CCs in a stroke width transformed image to obtain text region. Neumann et al. [4] posed the character detection problem as an efficient sequential selection from the set of Extremal Regions (ERs). Koo et al. [6] leveraged stability and even invariability of MSERs and took the detected MSERs as text candidates to locate the text. However, CC-based methods need post-processing to improve the detection performance, additional checks usually perform to remove false positives.

Sliding window methods, a sub-window scan through the image, to extract text features, and then use techniques of machine learning to distinguish text and non-text information. Wang et al. [11] have built an end-to-end scene text recognition system based on a sliding window character classifier using Random Ferns. The method adopted the sliding window to extract local texture features HOG, and then predicted the probability of each window contains text by the classifier. Bissacco et al. [12] used Convolution Neural Network (CNN) to train character classifier. The over-segmentation step divides the text line into segments that should contain no more than one character. Jaderberg et al. [14] achieve state-of-the-art performance by implementing sliding window detection as a byproduct of CNN. These methods tend to be slow because the image is often processed in multiple scales.

Some researchers present the hybrid method by taking advantages of both sliding window methods and CC-based methods. Pan et al. [15] extracts connected components as character candidates by local binarization; non-characters are eliminated with a

Conditional Random Fields (CRFs) model, and characters can finally be grouped into text. In the above methods, text detection based on the deep neural network method often can get better results. Therefore, we apply deep learning to investigate the problem of natural scene text detection.

3 Deep Neural Network ICPT-CNN

3.1 Architecture

In the paper, we proposed a deep neural network ICPT-CNN, containing five convolutional layers and one fully connected layer. The architecture of ICPT-CNN is presented in Fig. 1.

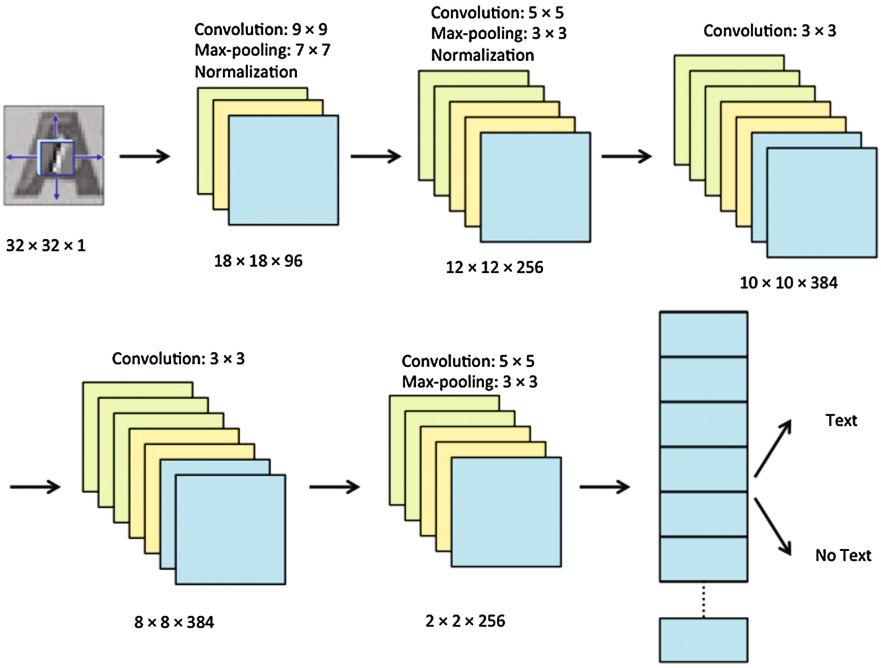

Fig. 1. The architecture of ICPT-CNN

The input is 32 × 32 fixed-size image patch. Starting from the first layer, the input convolves with 96 kernels of size 9 × 9, resulting in 96 feature maps. Each filter map is 24 × 24 to avoid boundary effects. The first convolutional layer intertwines with max pooling and normalization. Overlap pooling summarizes the outputs of 7 × 7 neighboring in the same kernel map and produce 18 × 18 × 96 feature maps. The second convolutional layer takes the output of the first convolutional layer as input, and then filters it with 256 kernels of size 5 × 5, 3 × 3 max pooling and normalized. The third

and fourth convolutional layer both have 384 kernels of size 3 × 3. These two convolutional layers are connected to one another without any intervening pooling and normalization. In the fifth convolutional layer, the output of the fourth layer convolves with 256 kernels of size 5 × 5 at stride of one pixel. Max pooling over the fifth convolutional response map to reduce the size down to 2 × 2. The fully connected layer has 1000 neurons. A binary classifier is used to estimate whether an input patch contains text.

We have made several technical improvements over a traditional convolutional neural network. First of all, we applied novel local response normalization in the first and second convolution layer. Traditional local contrast normalization normalized neighborhood features in the same response map. Given a pixel location, calculating weighted value of each pixel in its neighborhood (such as 3 × 3 window), subtract weighted values and then divided by a Euclidean norm (the window is pulled into 9-dimensional vector). The distance correlation of adjacent pixels is decided by these weights. A Gaussian weighting window may determine the weights. In order to adaptively deal with various image transformations, we hope the image local descriptors have invariance and high discrimination. Therefore, we improved the local normalization method of Jarrett et al. [16]. Our normalization implements a form of lateral inhibition inspired by the type found in real neurons, creating competition for activities amongst neuron in the same spatial location using different kernels. Suppose $a^i_{x,y}$ is the activity of a neuron computed by applying kernel i at position (x, y), local response normalized activity $b^i_{x,y}$ is computed according to the following:

$$b^i_{x,y} = a^i_{x,y} / \left(k + \alpha \sum_{j=\max(0,i-n/2)}^{\min(N-1,i+n/2)} \left(\alpha^j_{x,y} \right)^2 \right)^{\beta} \tag{1}$$

where N is the total number of kernels in the layer, k, n, α, β are hyper-parameters. Here we set $k = 2$, $n = 5$, $\alpha = 10^{-4}$, $\beta = 0.75$. Verification experiments show that using local response normalization can reduce the error rate to a certain extent.

In addition, we used Leaky ReLU (Rectified Linear Units) as the activation function in all convolution layers. The standard way to model a neuron's activation function is $f(x) = \tanh(x)$ or $f(x) = (1 + e^{-x})^{-1}$. Sigmoid function is saturating nonlinearity having an "S" shaped curve. In 2001, neuroscientist Dayan and Abott simulated the more accurate activation model of human-level neurons, as shown in the Fig. 2. The model is sparse activation and biological plausibility. Leaky ReLU function seems to be closer to the human brain activation model. In terms of training time with gradient descent, deep neural networks with ReLU train several times faster than their equivalents with sigmoid function [17]. In fact, the faster learning speed has a significant impact on the performance of deep network model if training data sets is very large. So in ICPT-CNN model, we selected Leaky ReLU replace sigmoid function as the activation function.

3.2 Learning

Training sets for network learning include 163 k positive samples and 900 k negative samples. The positive samples are similar to what Jaderberg [14] used to train the case-insensitive character classier. The positive samples are cropped 32 × 32

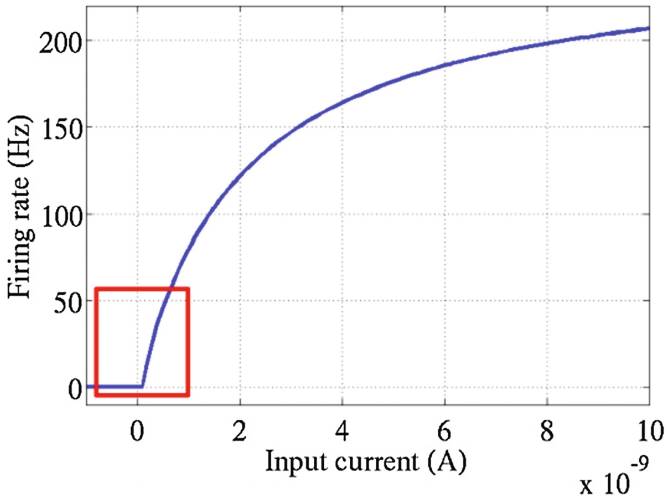

Fig. 2. Human brain activation model

characters from ICDAR 2003, 2005, 2011, 2013 training sets, KAIST, the natural images from Chars74k (we do not use the synthetically generated images). Some instances of copped characters are shown in Fig. 3. Negative samples are created by code programming, read some natural scene images from all four ICDAR training data sets, and cut out background images of size 32 × 32.

Fig. 3. Some training samples

In the training process, first initialize the ICPT - CNN convolution kernels, offset and other parameters. To learn the network use forward propagation on training samples. Then use back propagation algorithm to calculate the error of the network, and use stochastic gradient descent method to optimize parameters. After training, given a 32 × 32 pixel window, our deep neural network could detect whether it contains a character, use ICPT-CNN as a text/non-text classifier.

4 Text Detection

Taking advantage of the convolutional structure of ICPT-CNN to process the entire image, we used the learned the high-level hidden features to detect text. The proposed detection algorithm takes a high-resolution image as input, produce a series of text candidates. Each candidate box may contain text in the image. The process is tuned for high recall. Some overlapping and false positive candidates boxes are removed. Our text detection method includes the following stages, as show in Fig. 4.

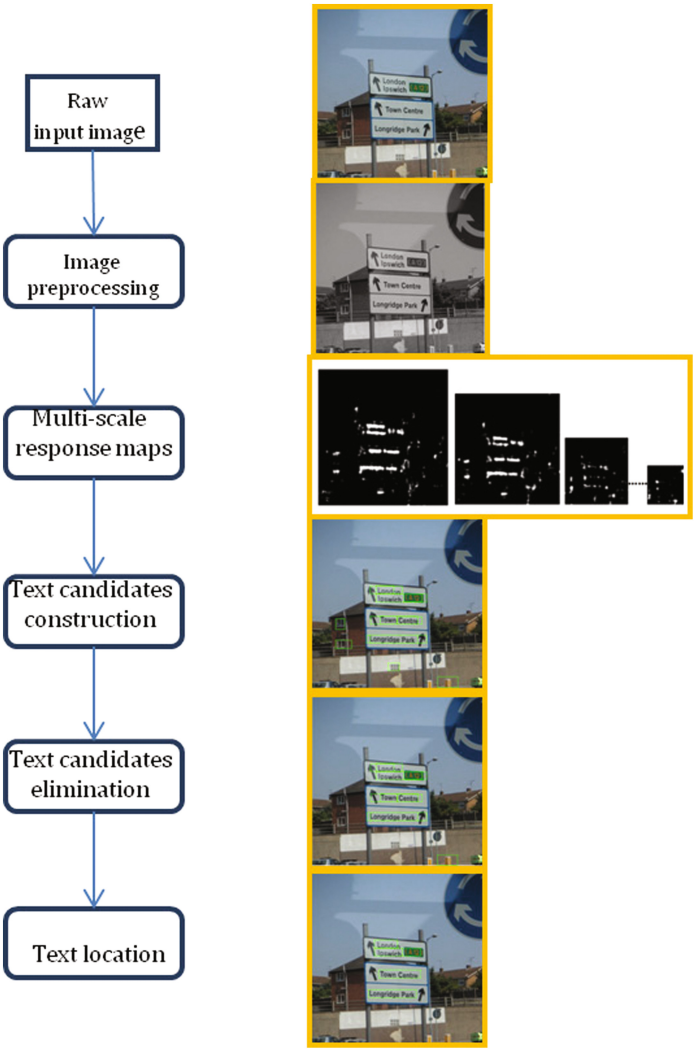

Fig. 4. Flowchart of the proposed text detection

The detection process starts from a large, raw input image. We slide a 32 × 32 pixel window across the input image. After the sliding windows are processed with five convolutional layers of ICPT-CNN, feed the inter-mediate hidden features into the classifier to analyze whether or not the windows contain text. In order to obtain more accurate location, we set 12 different scales in our method.

At a certain scale s, the input image's scale changes, the sliding window scan through the scaled image. If window contains a centered character, each point (x, y) in window produces positive response $R_s[x, y]$. In each row r of the scaled image, check whether there are $R_s[x, y] > 0$. If there exist positive detector response, then form a line-level bounding box L_s^r with the same height as the sliding window at scale s. And $max(x)$ and $min(x)$ are defined as the left and right boundaries of L_s^r. At different scale, sets of candidate bounding boxes are generated independently. Figure 5 shows the case of constructing text candidates at four different scales using positive response maps.

The above procedure was repeated 12 times, and yields groups of possibly overlapping bounding boxes. We then apply non-maximal suppression (NMS) to score each box and remove all boxes that overlaps by more than 50% with lower score, and obtain the final text bounding boxes.

Fig. 5. Construct text candidates at four different scales

5 Experiments

5.1 Deep Feature Representative Analysis

Detecting text in natural scenes, it is important to learn representative and discriminative text features. In order to verify strong representational power of the hierarchy

features learned by ICPT-CNN, we use the outputs of the first fifth convolutional layer as our discriminative features, from these features, we train a 37-way case-insensitive classifier and a 63-way case-sensitive character classifier on ICDAR 2003 cropped characters. 37-way characters are 26 English letters, 10 digits and background class. 63-way characters are 26 uppercase, 26 lowercase, 10 digits and background class. Table 1 shows the accuracy of classifiers for 37-way character classification, 63-way character classification. To make results comparable with three other popular algorithms, the background class is ignored in this case. All methods evaluate on ICDAR 2003 character test set.

Table 1. The accuracy of classifiers for 36-way classification and 62-way classification

Method	36-way case-insensitive classifier (%)	62-way case-sensitive classifier (%)
CNN-Wang [13]	–	83.9
HMM + Maxout [18]	89.8	86.0
CNN- Jaderberg [14]	91.0	86.8
Our ICPT-CNN	91.6	87.1

The first algorithm for comparison is End-to-End text recognition proposed by Wang et al. [13]. By leveraging the CNNs, to train powerful and robust text detection modules. But the network had only two convolutional layers. The multiple tasks in the recognition system shared feature maps learned by the two convolutional layers. As the network architecture is shallow, and in each network layer processing is a traditional convolution layer followed pooling layer. There are no other techniques to improve performance, so the 62-way character recognition accuracy was only 83.9%. The second algorithm for comparison is Hybrid HMM Maxout Models proposed by Alsharif and Pineau [18]. First segment word into possible characters using a Hybrid HMM/Maxout model, then leverage convolutional Maxout networks to recognize the character. A Maxout network [19] is a multilayer perceptron that makes heavy use of dropout to regularize the neural network and uses a max activation function that produces a sparse gradient. Specifically, for an input $x \in R^d$, every hidden layer implements the function $h_i(x) = \max (x^T W_{ij} + b_{ij})$. Our ICPT-CNN also improved from the sparse activation and complexity, applied the ReLUs directly on each layer instead of using max function, more simple and effective. The third algorithm for comparison is text spotting with CNNs developed by Jaderberg et al. [14]. The convolution layer intertwined with normalization, subsampling and max pooling for achieving translation invariance in a local neighborhood. This is similar to our ICPT-CNN architecture, but we used novel local response normalization to further improve the ability of feature representation.

As can be seen from Table 1, our trained classifiers sharing the first fifth layers of ICPT-CNN both achieve state-of-the-art performance, and improve results compared to

other learning models: +0.6% accuracy for the case-insensitive classifier and +0.4% accuracy for the case-sensitive classifier.

5.2 Experiments on ICDAR 2005 Dataset

To validate the performance of the proposed algorithm, we use the evaluation scheme of ICDAR 2003 competition [20]. The notation of precision and recall are defined as:

$$\Pr ecision = \sum\nolimits_{r_\sigma \in E} m(r_\sigma, T)/|E| \tag{2}$$

$$\text{Re}call = \sum\nolimits_{r_t \in} m(r_t, E)/|T| \tag{3}$$

Where $m(r, R)$ is the best match for a rectangle r in a set of rectangles R; E and T are our estimated rectangles and the ground truth rectangles respectively. We adopt the F-measure to combine the Precision and Recall figures into a single measure of quality, $F = 1/(\alpha/P + \alpha/R)$, where $\alpha = 0.5$.

We presented the experimental results of the proposed detection method on ICDAR 2005 Robust Reading and Text Locating dataset. Performance comparisons are implemented from the following two aspects: hand-engineered features based methods and CNNs based methods.

Table 2 aims to make a comparison of our method and other methods that use manually feature extraction for text detection. Hand-engineered features based methods usually extract the stroke width, the edge, the character structure and other features to design a text classifier for detection. From Table 2 can be found that our method produced much better precision and f-measure over other methods. The detection algorithms using the combination of artificial features haven't relatively well performing. It is worth noting that our algorithm has lower recall than SFT + TCDS algorithm. The main reason is that the SFT + TCDS is the improvement of SWT method. SWT is a pixel level detection method, by which even the low-resolution text could be detected. So it can give more text candidates and has higher recall.

Table 2. Performance Comparison with hand-engineered features based methods

Method	Precision	Recall	F-measure
Minetto et al. [21]	0.63	0.61	0.61
SWT [2]	0.73	0.60	0.66
Neumann and Matas [22]	0.65	0.64	0.63
Yi and Tian [23]	0.71	0.62	0.62
Yao et al. [24]	0.69	0.66	0.67
Chen et al. [25]	0.73	0.60	0.66
Yi and Tian [26]	0.71	0.62	0.63
SFT + TCDS [27]	0.81	**0.74**	0.72
Our ICPT-CNN	**0.84**	0.70	**0.76**

Table 3 compares our results with the recent work of [13] and [28]. All methods use deep neural network to extract features and locate the text. Overall, the performance of the ICPT-CNN is slightly superior to that of the CNNs used in other popular approaches. In the case with the same precision, F-scores of ICPT-CNN improved 1%. The basic implication of this improvement is that the discriminative features leaned by ICPT-CNN has a significant impact on the detection performance.

Table 3. Performance Comparison with CNNs based methods

Method	Precision	Recall	F-measure
Wang et al. [13]	–	–	0.742
Huang et al. [28]	0.84	0.67	0.75
Our ICPT-CNN	0.84	0.70	0.76

6 Conclusion

We have proposed an improved text detection algorithm with deep neural network. Our algorithm develops ICPT-CNN model, and combines feature learning and text detection as a complete process. In order to improve the performance of the network, we applied novel local response normalization to increase the ability of representation in the hidden features, and used the Leaky ReLU activation function to reduce the network complexity. By leveraging the representational power of ICPT-CNN, we are able to train highly accurate text detection model. Experiments on the standard benchmark show our method outperforms previous works and achieves a higher F-measure in every case. The experimental results suggest that the ICPT-CNN network architecture is reasonable, and the extracted jointly features are better, using which achieve a high accuracy for character recognition as well as text location.

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Analysis and System Simulation of Flight Vehicle Sliding Mode Control Algorithm Based on PID Neural Network

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Abstract. In recent years, the unmanned aerial vehicle has been widely concerned because of its simple structure, high flexibility and other advantages, and it is of important application value. Based on the current research achievements and related theories, a flight control algorithm based on the PID neural network is designed, and the feasibility of the algorithm is verified by simulation experiment. Experiments show that the controller on a basis of the new algorithm actually has excellent performance on the attitude and position control. It can be used to control the aircraft system in general and get better control effect.

Keywords: PID · Neural network · Sliding mode control algorithm

1 Introduction

Aguilar-Ibáñez [1] thought with the development of science and technology, unmanned aerial vehicle is playing an increasingly crucial role. The bright prospect of the application has attracted a host of researchers from the whole world. Li [2] thought that in the military field, the UAV plays an important role in carrying out numerous challenging tasks without endangering flying personnel's life (see Figs. 1 and 2). In the civil aspect, it also shows its great potential. Pounds [3] put forward that the main problem of aircraft research is to realize the design and application of the controller. Taking the external environment into consideration, it responds by establishing the controller parameter settings and logical relation. This effectively avoids the influence of the external factors, so that the aircraft can fly in accordance with the established trajectory and function. Shuyan [4] proposed that the controller is the core component of the aircraft, and its quality and performance, determine whether the aircraft can be used normally and achieve the best effect. Therefore, the development and application of the controller play an essential role in the development of aircraft. Hsu [5] thought that the aircraft is involved in the theory of knowledge and technology applications, such as the sensor and communication technology. Computer hardware, information systems management and design have characteristics of advanced technology and knowledge innovation.

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Fig. 1. UAV flight (a)

Fig. 2. UAV flight (b)

The remainder of this paper is organized as follows. On the basis of relevant basic theory, this paper studies the control algorithm of aircraft, and proposes a sliding mode algorithm according to the PID neural network. Section 2 discusses the principle and model of unmanned aerial vehicle and the traditional PID controller. Section 3 proposes

the design of sliding mode controller based on PID neural network. Section 4 carries out the simulation analysis. The conclusion is summarized in Sect. 5.

2 Background

2.1 The Principle and Model of Unmanned Aerial Vehicle

The unmanned aerial vehicle is a kind of equipment which does not need human driving control. According to the characteristics of parameters and control system design, it can achieve the expected flight trajectory of a series of operations in the air. Characterized by the structure and wing shape, there are two kinds of wings, fixed wing and rotary wing [6]. Fixed wing aircraft makes it forward by using the engine's thrust or pulling force. Currently the commonly-known rotating wing aircraft is the four rotor aircraft [7]. It does not need to run on the runway for takeoff, and is not required to fly through certain devices as well, which means it can take off in a smaller space [8]. Compared with the fixed wing UAV, the aircraft has the advantages of advanced technology, convenient use, light weight, small size, simple structure, easy control and so on.

The power system of four rotor aircraft is mainly composed of the engine and the rotor. It can achieve the lifting function because the engine drives the rotor to generate a lift force [9]. The speed of rotation determines the size of the lift force. In the process of flying, it can make attitude adjustment and control flight mode. In order to directly analyze the motion of aircraft, the corresponding coordinate axis is established. In the axis, X axis is the direction of the aircraft forward, Y axis is the direction of the aircraft left bank and Z axis is the direction of the aircraft uplink [10]. The value of lift force can be represented by the coordinate length. In general, there are hovering, vertical motion, pitching motion, rolling motion and yaw motion [11, 12].

Due to the influence of the external factors, the parameters of the aircraft are often highly variable; therefore, differential equations are needed to dynamically describe the dependent variables [13, 14]. Generally it can be described by two equations. The kinetic equation is mainly to analyze the relationship between the state of motion and the force and torque of the object. Kinematics is only to study the motion of the object, which do not consider the force, torque, etc.

2.2 PID Controller

PID control is the control method with the longest history. Its algorithm structure is simple, stable and reliable, and it can achieve better control effect without knowing accurate model of the system. PID controller contains three types of control, respectively, proportional control, integral control and differential control.

The output of the proportional controller is a kind of output based on the error ratio of the control system. Proportional controller will make the amount of control change in the direction of reduction. The greater the proportion coefficient is, the faster the reaction rate of the system would be, whereas the slower control speed is, the greater the static error would be. However, the extremely large ratio will cause the system to produce a shock; besides, the adjusting time would become longer, even the system

would appear overshoot or oscillation divergence. Due to this, system instability is inevitable. The output of the integral controller is the proportional output of the system error, which caused by the accumulated error of the system. Integral control can improve the control precision and eliminate the static error of the system. The greater the integral time constant is, the weaker the integral function is, on the contrary, the stronger the integral function is. However, if the integration time constant is too small, the system will produce the integral saturation, which leads to the increase of overshoot, even oscillation and instability. Integral control of the response is slow, and the resulting phase lags. Differential control is the proportion output of deviation rate of the system. The differential controller can forecast the deviation of the system, and restrain the deviation to the bigger direction change. Either too large or too small differential time constant will increase the overshoot of the system as well as the long time of adjustment. The appropriate differential time constant can help to reduce the overshoot, overcome the oscillation, and make the system more stable and enhance the dynamic performance of the system.

The design of the classical PID controller depends on the choice of the three parameters of the controller. In order to achieve the desired control effect, we must continually adjust the three parameters and determine whether the three parameters are consistent with the requirements according to the selected indicators.

3 Methodology

3.1 Design of PID Neural Network Controller

The PID neural network is a kind of multilayer neural network composed of proportional, integral and differential neurons, and it has the advantages of classical PID control and neural network control. Multivariable As to strong-coupled time-varying system, the output performance of the system can be automatically adjusted according to the change of the object parameters after setting the initial value through the on-line learning. By changing the proportion, integral and differential function of the network, such as the PID controller parameters tuning, to make the system have a good dynamic performance and to achieve the purpose of decoupling control system.

The PID neural network is a three layer forward network, which is composed of multiple sub networks. If the controlled object is an input m output, PID neural network is a network of $2n * 3n *$ m structure, which needs to be crossed and connected in parallel with n sub networks. The input layer to the hidden layer is independent of the sub network, and the hidden layer to the output layer is cross connected, and this combines the whole PID neural network as a whole. At any sampling time k, the PID neural network is provided with N output, and the forward calculation formula is as follows: the input layer has a 2n of the same neuron, and the relationship of its input and output is:

$$x_{si}(k) = u_{si}(k) \tag{1}$$

The hidden layer contains *3N* neurons, which are *n* proportional element, *n* integral element and *N* differential element. The formula of their input value is the same:

$$u'_{si}(k) = \sum_{i=1}^{2} w_{sij} x_{si}(k) \tag{2}$$

The output layer has n neurons, and forms n-dimensional output. There is no relation between the serial number of neurons of the output layer and the serial number of the sub network. The input of each output neuron is the weighted sum of the output value of all the neurons in the hidden layer, which is shown as follows.

$$u''_{h}(k) = \sum_{s=1}^{n} \sum_{j=1}^{3} w'_{sjh} x'_{sj}(k) \tag{3}$$

3.2 Establishment of Simulation System for Trunk Signal Control Optimization

The nonlinear system model has numerous uncertain factors which make the system parameters are inaccurate. Therefore, the dynamic system must be simplified. The sliding mode control is one of the best methods to deal with this kind of uncertain systems. The core of sliding mode variable structure control theory is based on the design of sliding mode surface for low order model. The trajectory, then is forced to fall into the sliding surface within the limited time, and has to maintain in the sliding surface at different times thereafter. There is no dependence between the motion and the uncertainties associated with the motion. Thus, this method can bypass the accuracy of the mathematical model and the external disturbance, so as to improve the stability and robustness of the system and traceability.

The main characteristic of the adaptive controller is that the parameters can be changed constantly; however the ordinary controller is not blessed with the advantage.

In addition, the adaptive controller also has the ability to correct the relevant parameters according to the external information. The actual control system has external disturbance, and the parameters are fuzzy. The total uncertainty of the external disturbance is assumed to have a slow changing property, and then the adaptive method can be used to estimate the uncertainty, and finally make the whole system more stable.

4 Data Derivation

After the control system is established, the simulation parameters are set up and each variable is initialized. The PID parameter is set to the initial value of the connection of the hidden layer to the output layer, and then input the first set of parameters. The simulation results are shown in Fig. 3.

It can be seen that if we choose the initial value which is of the appropriate connection weights, the output of the system will be equivalent to the output of the traditional PID control system; therefore, the initial value of the controller can be selected according to

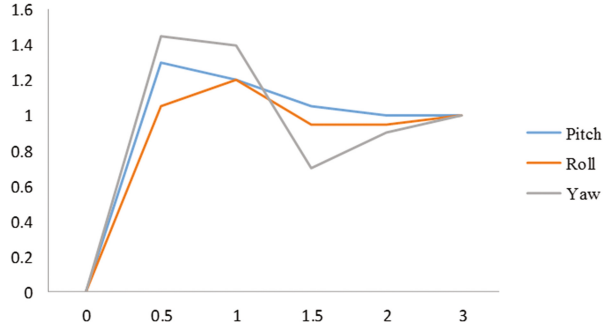

Fig. 3. The output of the system after initialization

the empirical PID value or the parameter setting method of the traditional PID controller. Training can be carried out after the initialization of the system. In this paper, the training of the three inputs is a jump function, and the objective function as shown in Fig. 4.

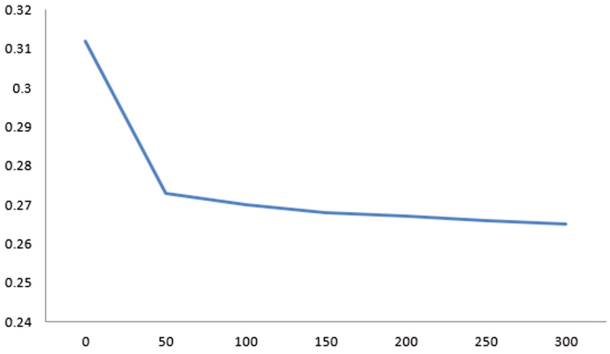

Fig. 4. Objective function value of the system

We can draw a conclusion that the controller realized the generalized structure control of the three inputs and three output strong coupling as well as the nonlinear aircraft system after training. The three controlled variables of the system are given respectively according to their respective input values, which are less affected by other given values. Thus, the response rate of the system is higher and the overshoot is smaller without static error. The objective function value of the system is rapidly decaying and monotonically decreasing through the whole training process.

5 Conclusion

Research on aircraft has already become the hotspot in the current academic circles and business circles. According to the domestic and foreign research achievements and the related theory, this paper studied the control algorithm and put forward the controller design of sliding mode controller based on PID neural network. The experimental results

show that the proposed algorithm is better than the traditional algorithm in terms of flying stabilization time and effect of flying to a destination, and it has definitely strong stability.

Due to the limitation of time and energy, the control system and dynamic model of the vehicle is still in the primary stage. In order to simplify the system, some of the forces have been neglected. The application of the control algorithm is also less, which needs to be further studied.

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Research and Implementation of Intelligent Risk Recognition Model Based on Engineering Construction of Neural Network

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Abstract. Since the reform and opening up, both domestic economy and people's living level acquire great improvement. People also pay more strong attention to risk issues of on-going engineering projects' construction. At present, science and technology have stepped onto high-speed development stage and the world is rapidly changing. Uncertainty of social external condition may lead enterprises to encounter more and larger risks during the construction process of engineering projects. Traditional engineering construction risk recognition model can't already fully and effectively identify risks. Therefore a new type of intelligent risk recognition mode is in urgently needed in construction of engineering projects. This paper proposes a kind of risk recognition model based on neural network so as to intelligently recognize different forms of potential risks, thus decreasing the damage from risks to a minimum. Relevant model below is established according to characteristics of engineering projects on purpose of doing quantitative analysis of risk rating in the engineering construction industry at present. It utilizes Genetic Algorithm to correct network, whose process increases accuracy and stability of all networks. Based on neural network, this paper establishes the model which could do risk rating during the project operation process in the engineering construction industry. It also does classification and research according to characteristics of potential risks in engineering projects, thus helping a project leader to more accurately predict, prevent and control risks, which guarantees safe and smooth operation of engineering projects.

Keywords: Uncertainty · Intelligent risk recognition model · Neural network · Risk rating

1 Introduction

Engineering construction would promote the development of national economy, which is the basic guarantee of rapid development of national economy. As supposedly-exceptional risks may appear in engineering projects' construction which involves people widely and keeps wide coverage, it is hard to imagine the consequences. Therefore, engineering construction generally needs large capital investment, long construction time, difficult construction process and complex technologies [1]. During the process of

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engineering projects' construction, risks present objectivity, necessity and uncertainty. Risks of engineering construction involve each participant which could be roughly divided into two types including proprietor and project contractor. Within construction stage of engineering projects, proprietors need to bear many risks which may derive from an objective external world, human factors or company's internal environment. Specifically speaking, proprietors need to afford investment risk, economic risk, political risk, natural risk, management risk and organization risk. Contractors take all the other risks except the above-mentioned ones.

Stephen C Ward proposed the method for dividing life-cycle of the project in 1995, which is specifically divided into 8 sections. It also elaborates risks of engineering projects in each section and their relevant characteristics. After that it establishes risk evaluation indexes of these engineering projects [2]. Geoff Cormy came up with concept system about risk management in 1998 which indicates the origin of the risk management concept and its main implementation steps and is utilized as a special dedicated system of engineering projects [3]. In the year of 2000, T M Williams raised that methods on risk measurement in the past meet certain disadvantages in which traditional methods cannot fully expose important information about risks and internal relationship exists among all risks. It quantifies relevant risk factors [4]. Analytic Hierarchy Process with abbreviation AHP has been better applied to multiple scheme evaluation and has made great progress on multiple factor analysis after it appeared. Then it was also utilized in risk assessment of engineering projects which acquires good assessment results. In the year 2011, Raz proposed that dynamic evaluation must be done on the possible and actually suffered the risks of each link during the process of engineering construction for the sake of improving the risk management level of electric power engineering projects. It was also targeted to propose risk control measures [5]. In order to do further research [6], Shanshan Qiao raises the method of optimizing BP Neural Network through utilizing Genetic Algorithm and applies this new theoretical model to quotation decision, in which this optimized model is determined to keep the advantages and feasibility in quotation decision through comparison with other existing quotation methods [7]. Ying Li, Aihua Wang et al. proved that Bayesian - regularization method could be utilized in engineering project assessment through verifying examples under the premise that BP Neural Network is still at the initial stage of research on engineering project assessment, which is in lack of theoretical and practical experience. This method has advantages of high accuracy and automatic normalization [8]. Complicated nonlinear mapping relation [9]. Zhenxing Wang introduces Neural Network Theory in the risk evaluation of the hydraulic engineering construction project, which establishes a risk evaluation index system in its engineering construction, builds relevant BP Neural Network model to do project risk evaluation and utilizes relevant examples to verify its feasibility [10].

Through doing further research and analysis on various risks appearing in engineering projects, this paper proposes recommendation strategies on domestic construction industry proceeding from quantitative level and combining with a risk analysis of the overseas engineering construction industry. It is aimed at working out a type of intelligent recognition model to study risks in project construction thus increasing comprehensive risk management level in the domestic construction industry. Do research and innovation on the basis of traditional risk recognition model theory. Based

on combining with risk theory, this paper emphatically analyzes the important parts. On the premise of doing recognition, prediction and final evaluation of risks, this paper generalizes warning legal risk indicators about the construction industry. It establishes an intelligent recognition model of engineering construction risks and does accurately optimization on network through using genetic algorithm in the background of neural network, which not only shortens model establishment procedure but also explains the whole operation process of system in detail. Research on networked governance theories realizes legal risk warning, institutionalization and networking of engineering construction risks.

2 Model Establishment

Generic self-learning network is composed of dynamic linking multiple layer combination, in which barrier exists between layer and layer. Network group characteristics of generic self-learning network are mapping links self-learning, whose algorithm feature architecture and self-learning rules keep hierarchy with other network types. Generic self-learning network keeps functions of the association, speculation, memorization and logical judgment modeled after brain, nerve, whose application in various industries acquires success and feasibility is verified by countless engineering practice [11]. Network architecture of generic self-learning network is different from those of other networks. As fault tolerant performance of generic self-learning network is weak, genetic algorithm is introduced to do optimization thus increasing robustness. Set the error function as a target adaptive function. The precision of the model and robustness are increased through combining with generic self-learning network and genetic algorithm. Figure 1 is a network flow diagram.

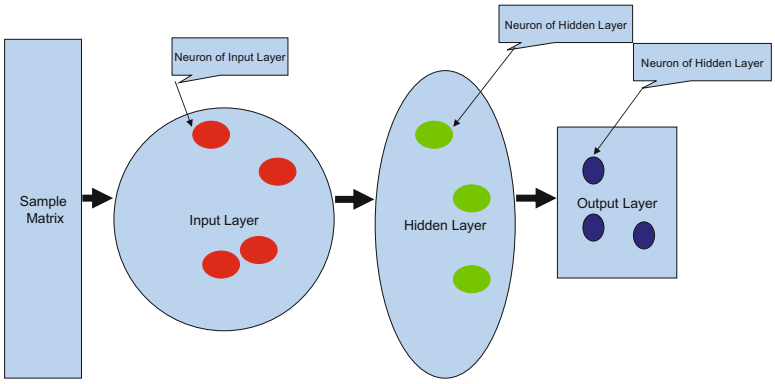

Fig. 1. Network flow diagram

The network base layer is network type which is not designed for calculating. Therefore, it is not real neurons. The second layer of neurons is real neurons, which evaluates continued product of type value and weight and then cumulatively sums them. Print value appears after nonlinear transformation processing, in which is permission

function. Do judgment on print value. If it is more than 0, output value is the set value 1. If it is less than 0, the output value becomes −1. Its calculation formula is seen as follows.

$$u_j = \sum_i w_{ij} y_i + x_j \tag{1}$$

x_j is external type value in Formula 1–1 which caters for the following one.

$$\begin{cases} y_j = 1, \ u_j \geq 0 \\ y_j = -1, \ u_j \leq 0 \end{cases} \tag{2}$$

Output of generic self-learning network has relationships with tense. Moment t outputs, one dimensional vector n which is an integration of meta-information [12].

$$Y(t) = [y_1(t), y_2(t), y_3(t), \ldots y_n(t)]^T \tag{3}$$

Node state of generic self-learning network changes with time t. $y_i(t)(i = 1, 2, \ldots n)$ could be 1, −1 or other number standing for state. In conclusion, it has 2^n kinds of state. This time meta-state helps deduce the state of the next moment whose formula is seen as follows.

$$y_j(t+1) = f[u_j(t)] = \begin{cases} 1, & u_j(t) \geq 0 \\ -1, & u_j(t) < 0 \end{cases} \tag{4}$$

$$u_j(t) = \sum_{t=1}^{n} w_{ij} y_i(t) + x_j - \theta_j \tag{5}$$

The evolutionary process of generic self-learning network is a dynamic mode whose meta-state keeps dynamic features. Its process caters for Lyapunov Function. Being similar to the natural world, it advances towards the direction of power decreasing. When the network reaches a balance value, the state would be print value [13].

Network working has both serial mode and parallel mode, which is different. Their operation steps are seen below.

The first step: Initial generic self-learning network.

The second step: Randomly choose Element i.

The third step: Calculate the output element $u_i(t)$ at t Moment.

The fourth step: Calculate the output $v_i(t-1)$ of the Element i at $t-1$ Moment and keep print values of other elements constant.

The fifth step: Give discrimination of stable states and do circulate. A stable state means that its output does not change from t_i Moment.

$$v(t + \Delta t) = v(t) \quad \Delta t > 0 \tag{6}$$

Optimization strategies of genetic algorithm for generic self-learning network are expressed in the following Fig. 2 [14].

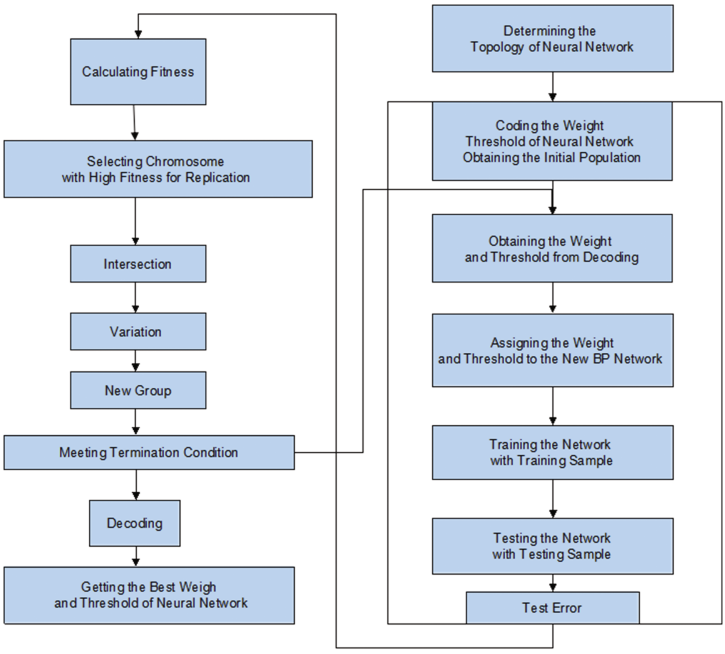

Fig. 2. Optimization strategy diagram

3 Model Solutions

Through extracting operation data in the engineering construction industry, do tagging on risk data possibly appearing during the project construction process and extract relevant characteristics. Do network training on these characteristics. Characteristic classifications of risks in engineering construction include diversity, individual character, objectivity, universality, chance, variability, relativity, long term, entirety, regularity, relevance, uncertainty and complexity.

Do visualized operation on the thirteen extracted characteristics and do space mapping on different ones through which transforms data into network approved mode. Its three-dimensional view is in Fig. 3.

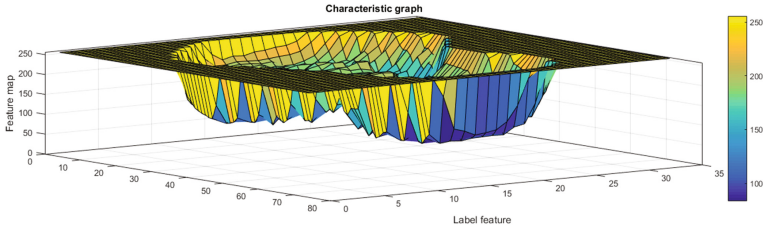

Fig. 3. Three-dimensional view of characteristics

Train data in the engineering construction industry through customizing personalized network training model thus acquiring implicit network model. Realize classification and label treatment of possible risks during the project operation process through mapping thus achieving macro-control and real-time warning on the operating state of the construction industry, which helps avoid risks and increase overall efficiency of enterprises.

Construct an interactive model according to MATLAB. Divide user data input into two layers, one of which records text label information and the other of which records numerical information. Computing layer is designed to be a two-layer model which does advanced treatment of data. The establishment of two-layer computing model increases nonlinear decoupling capability. Figure 4 shows the constructed network model.

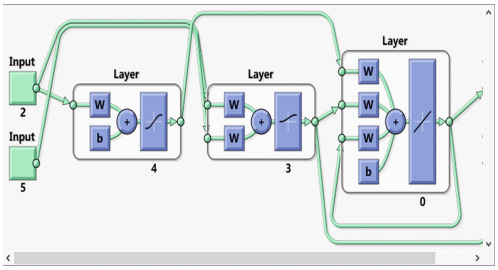

Fig. 4. Network model diagram

Through being optimized by a genetic algorithm, generalized network realizes convergence after 4565 times of iteration. Visualization leads the convergence process to simplify cross-verification. Convergence curves are shown in the following Fig. 5.

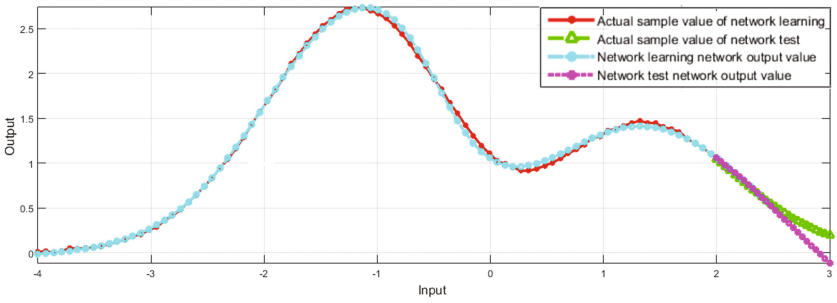

Fig. 5. Convergence curves

Utilize intelligent recognition model to divide the risks during engineering construction operation into seven categories whose ratings have seven grades. They are AAA, AA, A, BBB, BB, B and CCC, which respectively stand for risk with negligible influence, risk of little influence, risk of general influence, risk with great influence, risk with high influence, risk with serious influence and risk of disastrous influence. Figure 6 shows their proportions and classifications.

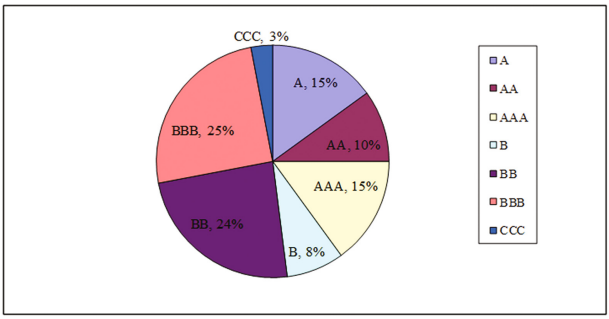

Fig. 6. Proportion and classification diagram of risks

It is seen from operation data in construction industry classified by algorithm that most risks keep potentially harmful characteristics. In order to intuitively observe the situation of risks in multidimensional space after they are classified, mapped the seven-dimensional space to three-dimensional space. Three-dimensional histogram also clearly shows proportions of risks with different characteristics and their positions [15], which is seen in Fig. 7.

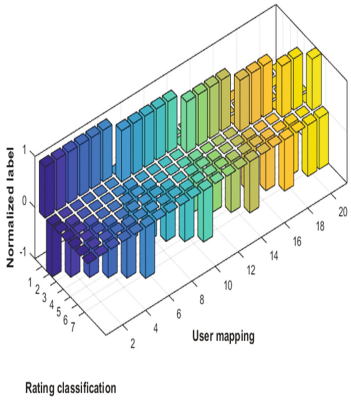

Fig. 7. Three-dimensional histogram of proportions and positions of risks with different characteristics

4 Conclusions

This paper is aimed at doing research on the model which could intelligently recognize risks in engineering construction and realizes it or does optimization on the model with existing risks thus making it. It is known from the section above that genetic algorithm could strengthen the reliability of the established network and increase its accuracy. A neural network could be utilized to analyze procedure of construction industry. Neural network tending to be more mature could be applied to establish the risk rating model

[16]. This paper divides risks into thirteen categories according to characteristics. Further extending on account of all types of risks effectively leads managers to foresee risks of projects in time and makes them get everything ready beforehand, thus doing their best to reduce the influences of risks to a minimum. This paper also utilizes intelligent algorithm and risk rating algorithm to establish relevant algorithm platforms, thus laying foundation for widely spreading of intelligent algorithm.

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Developing Green Construction Evaluation System Based on Deep Neural Network Algorithm

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Abstract. The green construction evaluation model is a multi objective and multi qualified model, and the solution has a certain degree of complexity. Often a single algorithm cannot be a good solution to the accuracy of the evaluation system and fault tolerance capabilities and other issues. This paper, through empirical analysis and application of the actual construction of the data depth network model is constructed, in complex models in the abstract condition as factors and as neural network input and output node information and the network optimize. By introducing the ant colony algorithm to train the neural network's cost function, the paper obtains the high precision model of the green construction evaluation system and the new optimization method for solving the traditional problem. Through the algorithm of organic fusion, the existing algorithms are improved, and the reliability and accuracy of the algorithm are improved. It provides a new theoretical basis and practical model for the green construction evaluation system.

Keywords: Green construction · Neural network · Ant colony algorithm · Fusion algorithm

1 Introduction

Construction projects are a complex process with high technical difficulty, difficult management, and high risk. As in the development of China's economy, the policy support vigorously develops the infrastructure construction and the people's livelihood construction, the economy made a very large advance, and at the same time, there are many problems to be solved, such as ecology, efficiency, security and so on [1]. Most of the evaluation system is based on classical mathematical model, such as fuzzy mathematics, statistics, and so on. Through the development and optimization of these theories in the construction evaluation system has been mature, widely used, but with the construction technology and the construction scale of ascension, the evaluation complexity also showed geometric quantity growth. How to large and complex engineering, precision evaluation is a major issue, which is placed in front of the researchers, this paper constructs a depth study network model, the complex system of

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many factors are taken into account, the network self-learning ability of index system of selection and evaluation function fitting. Aiming at the problem of difficulty in cost function training and slow convergence rate, the ant colony algorithm is introduced to optimize the algorithm, which improves the accuracy and robustness of the algorithm. In this paper, a new intelligent algorithm is integrated in recent years to carry out an objective and high precision evaluation of the green construction system.

2 Problem Description and Algorithm Flow

2.1 Overview of Neural Networks

Artificial Neural Network is from the information processing point of view of the neurons in the network abstraction, to establish some simple model, according to the different composition of different network connection. In engineering and academia also often referred to as a neural network or direct neural networks. The neural network is a computing model, by the large number of nodes (or neurons) interconnected between the constitution. Each node represents a specific output function, called activation function (activation function). Each connection between two nodes represents a weighted value for the connection signal, known as a weight, which is equivalent to the memory of artificial neural networks. The output of the network is connected by way of a network, and different weights of the different activation functions. The network itself is usually some kind of nature or function approximation, it may be the expression of a logical strategy.

For years, people from medicine, biology, physiology, philosophy, information science, computer science, cognitive science, science and other organizational collaboration and understanding all angles attempt to answer these problems. Looking for answers to these questions in the course of the study, and gradually formed a new interdisciplinary field of technology, called “neural networks”. Scientists in different fields of interest and from the respective disciplines and specialties departure, ask different questions, studied from different angles.

Artificial neural networks have an initial capacity of adaptive and self-organizing. Changing synaptic weights in the learning or training process in order to meet the requirements of the surrounding environment. The same network because of different learning styles and content can have different functions. An Artificial neural network is a system capable of learning, knowledge can be developed, so that the level of knowledge than the original designers. Usually, it’s learning and training can be divided into two, one is called supervised or supervised learning, this time using a given sample standard classification or imitation; the other is called unsupervised learning or inaction of Learning in this case, only the provisions of certain rules or learning styles, learning content with the specific environment in which the system (i.e., the input signal case) varies, the system can automatically discover environmental characteristics and regularity, has a function more closely the human brain.

The neural network is like a love of learning in children, you teach her the knowledge she will not forget and will apply their knowledge. We study set (Learning Set) each input to the neural network, the neural network output and tells what should be classified. After learning all the sets are run to completion, the neural network is

summarized according to the examples of her ideas, in the end is how she summed up is a black box. Then we can put the test set (Testing Set) in the test case using a neural network, respectively, for testing, if the testing (such as 80% or 90% of the correct rate), then the neural network is constructed successfully. After this we can use neural networks to determine the classification of the transaction.

Neural networks are through the basic unit of the human brain - neurons and coupled modeling, simulation model to explore the human brain system functions, and to develop a kind of learning, associative memory and pattern recognition and artificial intelligence information processing function system. An important characteristic of neural networks is that it can learn from the environment, and the distribution of the results of synaptic learning stored in the network connection. Learning neural network is a process, inspired by their environment, and have been for some sample network input mode, and in accordance with certain rules (learning algorithms) to adjust the network weight matrix layers until all layers of the network weights converges to a certain value, the learning process ends. Then we can do to generate neural network classification of real data. We all know that the learner has some knowledge and experience will play an important role in the new learning process. Therefore, it has an important influence factor in the teaching process, teachers and students the elements, the teaching materials, teaching materials and environmental conditions. “Pluralistic Interaction” in the “interactive” refers to the full use of various teaching elements, towards interactive, encouraging students to actively participate in the learning, teaching effectiveness to achieve effective and high-quality series of teaching and learning activities. Have an organic whole between the various activities and more to teaching and interactive teaching elements, subject and object is to achieve a dialectical unity, goals and dynamically generated teaching. The so-called “multiple interactive” teaching mode under the information technology environment is diverse and dynamic interactive communication teaching activities. Mobilize and take the initiative to promote student learning activities, implement new forms of teaching structure, all-round, multi-level development. Multiple interactive teaching refers to teachers and students of English as a body double in College English Teaching. In this process, the main role of the teacher is to guide, promote students’ foreign language learning. The process allows students to explore, practice and interaction (See Fig. 1).

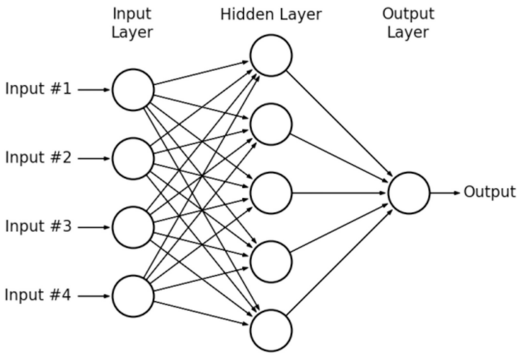

Fig. 1. Overview of neural networks

Neural network construction is generally through the framework for the model as $m \times n \times l$.

Namely the m layer type vector, the N layer of the intermediate computing matrix, l layer print vector. Set the dimension of the parameter matrix, the first column θ_1, the second column θ_2, by analogy, parameter $\{\theta_1, \theta_2, \ldots \theta_n\}$ type the corresponding vector and intermediate calculation matrix links coefficient and the intermediate link coefficient matrix and print vector is calculated [2].

After the structure of the network structure, the network needs to be calculated as well as the function cost print output [3]. By canceling the bias option, the function cost can be simplified as:

$$J(\theta) = \frac{1}{m}\sum_{i=1}^{m}\sum_{k=1}^{K}\left[-y_k^{(i)}\log\left(\left(h_\theta\left(x^{(i)}\right)\right)_k\right) - \left(1 - y_k^{(i)}\right)\log\left(1 - \left(h_\theta\left(x^{(i)}\right)\right)_k\right)\right] \quad (1)$$

It can be seen that $h_\theta(x^{(i)})$ can be calculated by the link between the various elements, in which the K = 6 as a whole map tag value. Among them, $h_\theta(x^{(i)})_k = a_k^{(3)}$ is the first k trigger function in the print vector. For the convenience of calculation, the original tag was mapped, and the $\{0, 1\}$ value was identified.

$$y = \begin{bmatrix} 1 \\ 0 \\ \vdots \\ 0 \end{bmatrix}, \quad y = \begin{bmatrix} 0 \\ 1 \\ \vdots \\ 0 \end{bmatrix}, \quad y = \cdots, \quad y = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 1 \end{bmatrix}$$

In the original matrix, if the mapping value of label 5 is $x^{(i)}$, the corresponding $y^{(i)}$ (calculated by function cost) corresponds to the dimension of the number of vectors in which $y_5 = 1$. The rest of the elements are $y_i = 0$.

The mapping function is set to sigmoid(), and its specific expression is:

$$sigmoid(z) = g(z) = \frac{1}{1 + e^{-z}} \quad (2)$$

It carries on the partial derivative operation, the partial derivative computer solution form is:

$$g'(z) = \frac{d}{dz}g(z) = g(z)(1 - g(z)) \quad (3)$$

For the final column vector corresponding to the output value, can be explicitly calculated for the $\delta_j^{(l)}$, for the middle of the link node, through the weighted calculation of the layer can get the layer of $\delta_j^{(l)}$, that is:

$$\begin{aligned} L+1 &\mapsto L \\ R^{L+1} &\Rightarrow R^{L} \end{aligned} \tag{4}$$

The network cost mapping matrix calculation is completed after the gradient calculation and test, the algorithm will complete the steps above, it should be followed network parameter learning, selected function learning is often able to obtain a good parameter set. But the face of qualitative evaluation problems often classical algorithms cannot well solve the problem of fault tolerance and robustness. In this paper, the ant colony algorithm is introduced into the neural network, through suitable for the discrete problem solving biological intelligent search algorithm of optimum of the extremism value of the cost function, it is possible to obtain high adaptability of the algorithm.

2.2 Ant Colony Algorithm and Its Combination with Neural Network

Ant colony algorithms in the cost function find good mainly for the implementation of the three steps. First of all, the solution space is discredited as contiguous regions, i.e., a space, by placing elements (ANT) the iterative search, of elements was screened to set the rules for the implementation, so as to update the solution. By setting the rules, the update is mapped to the two layers, the first layer is a local update, when the elements traverse the information receiving element, the bearing information node is reduced, which can obtain the probability of the non ergotic point is traversed. Self-learning formula [4]:

$$\tau_{ijk} = (1-\varsigma)\tau_{ijk} \tag{5}$$

Among them, τ_{ijk} is the information element of a point in the three-dimensional domain. ς as attenuation factor.

The second layer is all domain self-updating, the definition of elements after traversing a path to the path of the norm as the dependent variable, this collection of minimum norm value for screening out, get extra path information element, updating the model for:

$$\tau_{ijk} = (1-\rho)\tau_{ijk} + \rho\Delta\tau_{ijk} \tag{6}$$

$$\Delta\tau_{\mathrm{ijk}} = \frac{K}{\min(length(m))} \tag{7}$$

The formula length (m) for the element traversal norm, P is element updating proportion, K is the overall balance coefficient [5].

3 Analytical Discussion

To train the evaluation factor, set the number of training set as N. This paper selects 17 projects for training, through the empirical analysis, literature collection, engineering case, 25 projects selected for data cleaning after into the neural network for training, the neural network architecture set as input layer 17 layer, the hidden layer for the 10×12 matrix, the output layer to layer 5. For the cost function, the training procedure is as follows [6–8]:

Set random, initial and midpoint, set the element to traverse the trigger function:

$$H(i,j,k) = D(i,j,k)^{\backslash w_1} \cdot S(i,j,k)^{w2} Q(i,j,k)^{w3} \tag{8}$$

$D(i,j,k)$ is set to norm, the element is given priority to select the minimum value, and $S(i,j,k)$ is the element safety evaluation index, and $Q(i,j,k)$ is the norm for the next target.

The formula of $D(i,j,k)$ is:

$$D(i,j,k) = \left[(x_a - x_b)^2 + (y_a - y_b)^2 + (z_a - z_b)^2\right]^{\frac{1}{2}} \tag{9}$$

The formula of $S(i,j,k)$ is:

$$S(i,j,k) = \frac{N - M}{N} \tag{10}$$

The formula of $Q(i,j,k)$ is:

$$Q(i,j,k) = \left[(x_b - x_d)^2 + (y_b - y_d)^2 + (z_b - z_d)^2\right] \tag{11}$$

MATLAB program for the preparation of neural network training, after 27 times the training to achieve convergence, the parameter selection process of three-dimensional graphics see Figs. 2 and 3.

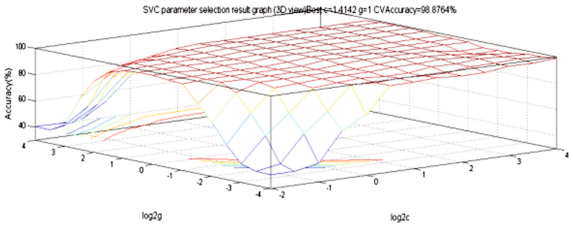

Fig. 2. 3D parameter selection results chart

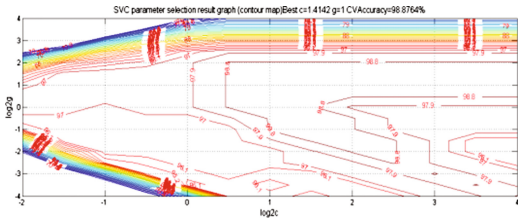

Fig. 3. Parameter training contour map

By the parameter selection diagram shows parameter training density, concentration distribution in edge, for mapping data reflects its own characteristics of the evaluation system, through the parameter selection and correction, to improve the accuracy and robustness of the evaluation model.

4 Prospects

Ant colony algorithm as the representative of intelligent group, greatly develop the scientific research personnel's ideas and to explore the range, has gradually become a research hotspot in the fields. In this paper through the neural network to construct depth models and optimize, improve the robustness and accuracy of the algorithm. In the complex model by using the ant colony algorithm to train the neural network optimization and, won the green construction evaluation system, model and solution, the depth of the ant colony algorithm applied to promote and inspired. Through the algorithm of organic fusion, we can innovate and improve the existing algorithms, and improve the reliability and accuracy of the application.

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Multiagent and Recommender Intelligent Systems

Determination of the Table Tennis Placement Based on Artificial Intelligence

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Abstract. The table tennis is complex and changeable. With table tennis in-depth study, the importance of placement judgment gradually is appearing. In this paper, we use the experimental method to divide the test objects into professional group and amateur group, and collect these game data. Nowadays, Artificial Intelligence already permeated into all fields. It is common that research of sporting events based on computer. We also used Artificial Intelligence methods for data diagnosis and evaluation. The results showed that the professional group, according to the ball strength and speed rotation to make a good judge, yet lack the ability to judge by amateur groups. About the reaction time and accuracy, professional group is better than an amateur. Professional group has a more efficient ability of placement judgment. Analyzing placement judgment of table tennis should be an important capability for athletes and get more attention from the majority of athletes and coaches, to achieve better race results.

Keywords: Artificial intelligence · Fall point · Diagnosis, sports intelligent analysis

1 Introduction

Physical education is a required subject in the education of colleges and universities, it is one of the important parts for the cultivation of talents in colleges and universities, for the growth of the students' physical and mental health and form has a very important role, is also a very welcomed by college students of a course, as shown in Fig. 1, ongoing physical education for college students to study and training.

As an international table tennis tournament, has been widely popular with the public. Whether pros or amateurs, are often that find their own style. But in the game of table tennis, the ball movement often influenced by multiple factors, researchers have been winning from kinds of angles to analyze competitive manner. In terms of speed and rotation, it can be quantitatively analyzed in terms of the arc and strength, a lot of qualitative research, but the placement of the ball is determined on this issue, to study relatively less.

Aiming at this problem, focusing on the placement of the ball is determined to study. Table Tennis tournament has been achieved by the quantitative and qualitative to a

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Fig. 1. The physical education course in universities (Source: Beijing Sport University City)

combination of both; from a simple means of using computer technology to simulate rely on the manual way to statistical development [1]. Artificial intelligence as an advanced machine learning methods has been demonstrated in many studies in motion its application, how to rely on artificial intelligence research, auxiliary ball games, using its integrated system of judgment, evaluation and forecasting, as well as paper focuses on the emphasis.

The second part of this paper, the research status and research methods were analyzed and summarized. And the third part of the study is determined by using the experimental data collection. The part four bases on the part three to use Artificial Intelligence methods for data diagnosis, assessment and prediction. After that, the fifth part is results in a conclusion.

2 Fall Point and Computer Simulations

2.1 The Agent and Multi Agent System Is Reviewed

The concept of the Agent: under the weak concept, the Agent have the following abilities: autonomy, can run without outside intervention, and it for their own behavior and the internal state has certain control; Social ability, can exchange information with other Agent, and the impact on other ACTS of the Agent; Response capabilities can sense the environment and impact on the environment to a certain response to the environment; Dynamic ability, can accept certain information, so as to make a goal-oriented behavior. Under the strong concept, Agent in addition to the above characteristics should also

possess certain human characteristics, such as knowledge, belief, intention and commitment to the mental state (Hu, Lu, Shi, 2001) [6].

Multi Agent system, the distributed artificial intelligence research goal is to want to through the computer system model to describe the natural and social systems, in distributed artificial intelligence, the concept of intelligence is not an independent existence, need the group to be able to realize, so the distributed artificial intelligence research is primarily between multiple Agent cooperation, interaction, etc. Multi Agent technology has the autonomy, distribution and coordination and has a self-organizing ability, learning ability and reasoning. The Multi Agent system is composed of more than one Agent in a certain way collection, multi Agent technology is a qualitative leap of artificial intelligent technology.

2.2 Studies on the Fall Point Determination

Table tennis athletes' placement refers to an effective form to hit the ball to the other side of the table pops up that point, it usually called "Fall Point". The main role of placement includes the other side to expand the range of movement and press competitors' weaknesses as well as to suppress the other prominent technology play and attack each other moving in opposite directions with the judge and so on.

In the past, research scholars first concerned about the athletes' ability to judge the ball's direction of experimental studies, the results showed that with the extension of opponents, stopping point in time, the player will increase the amount of information to predict, predict the exact rate will rise [2]. Subsequently, some scholars to study the placement of the ball in table tennis ball scoring rate changes on the impact of the conclusion that: big comeback to change the difficulty of the ball before and after the placement of the ball is about to change big comeback with the same placement. The placement of the ball to great change, and if the athlete can be judged accurately, move fast footwork, choose the right ball position, the ball scoring rate was not significantly different from the average scoring rate of athletes. If the athlete can't hit the ball in place, it is almost not score.

These results can be explained, studies determine placement of technology strategy for athletes have an important impact.

2.3 Based on Computer Simulations of the Game Diagnosis

With the development of computer software technology, especially the development of database technology, making the collection and processing of large amounts of data easy, fast and efficient. It also makes the game of table tennis technical and tactical assessment approach has been a huge breakthrough [3]. Past in order to simplify the manual workload statistics, the statistical indicators have to simplify the game, but now you can rely on computer software to collect data to match the bottom. At 2004, table tennis competitions method of data acquisition and multimedia break technical and tactical analysis of the national table tennis team for the start of the World Championships and Olympic Games and opponents to prepare for analysis, and received good results. Computer software, data acquisition features include: shoot the ball as the basic

unit acquisition position of the player, hit technical and tactical affairs, shot placement, rotation and other 21 basic data. Compared with the past, points (gains or losses) units, the collected data is more delicate [4]. Figure 2 is a system of artificial intelligence and the human race scene.

Fig. 2. A system of artificial intelligence raced with human (simulation exercise)

3 Methodology

3.1 Objects of the Research

This paper selected institute of Sport College (Beijing Sports University) majors in 20 sports as a professional group, in which each of 10 men and women, asked to participate in table tennis level testers for the country second-level players or more [5]. Amateur group, institute, department of education selected 20 ordinary undergraduates, wherein each of 10 men and women, asked to participate in testing personnel did not participate in rigorous training (Table 1).

Table 1. The basic information of participate in the test

Group	Gender	Average age (years)	Sports life (years)	Sport level	Total
Professional	Male	22.33	7.6	Second-level	10
Professional	Female	22.17	7.3	Second-level	10
Amateur	Male	22.56	0	Null	10
Amateur	Female	21.79	0	Null	10

3.2 Artificial Neural Networks

Since the artificial neural network to simulate the human brain way of thinking, it has the ability to solve many complex nonlinear systems, the strong self-organization, self-learning ability of the system to make it fit higher accuracy, it is strong fault tolerance and adaptability to make many of the traditional mathematical problems be solved [6]. Neural network function approximation of nonlinear system strong technical and tactical capabilities for ball games diagnosis provides a good idea. If we can choose a set of indicators can fully reflect the system's technical and tactical game, and select the appropriate training methods, neural networks can be simulated through training after the game, when the change will affect its input to its output, which is the reality of the ball class game similar [7]. The establishment of a new model to input data, or build neural networks based on the recent game data, to complete the game predictive analysis. In summary, the training can be done by artificial neural network table tennis tournament the following Decision Analysis: Techniques and Tactics of Table Tennis Match Fit game winning probability data and to establish the technical and tactical game of table tennis model; adjusting the input value of the network, observe the technical and tactical indicators of the impact of winning the game, the game of table tennis diagnosis; weighted average of the table tennis competition evaluated based on the results of the diagnosis; recent data related to race training, the game of Table tennis prediction analysis [8].

Genetic algorithm (GA) is mimic natural biological evolution process calculation model. It contains, according to the rules of the evolution of the survival of the fittest, superior bad discard solution group repeated genetic operation, constantly produce new individual. The General process of genetic algorithm begins to represent a population of potential solutions, and a population is by a gene encoding a certain number of individuals. Each individual is in fact a chromosome with characteristics of the entity. Chromosome as the main carrier of genetic material, that is, a collection of multiple genes, their internal performance (genotype) is the combination of a gene, it determines the external performance of the individual shapes [9]. Therefore, before using the genetic algorithm, first of all need to implement from phenotype to genotype map coding. Coding way, mainly binary code and real number coding, symbol encoding and extension of the plural coding and tree structure coding, etc. After generating the initial population, according to the principle of survival of the fittest, superior bad discards, generational evolution to produce more and more excellent approximate solution. Individuals in each generation, according to the problem domain size of the fitness of selected individuals, and by means of natural genetics, genetic operators are combined crossover and mutation, produced on behalf of the new solution set of the population. The Genetic algorithm in the genetic operation in the whole process of evolution is random, but it presents the characteristic is not completely random search, it can effectively use historical information to speculate that the next generation of expected performance improved set of finding advantages. So the final convergence to generations of evolution one of the most to adapt to the environment of the individual, calculate the optimal solution of the problem [10].

The BP neural network is short for error back propagation neural network, the typical BP neural network is made up of an input layer, one or more hidden layer and one output

layer, each layer is composed of a certain number of neurons. These neurons as a man of nerve cells are associated with each other. The internal control evaluation, based on the needs of research and the realization of the conveniences and the effect of information processing, we use is also a three layers BP neural network, including an input layer, one hidden layer and one output layer, which containing 22 neurons in the input layer, hidden layer, including five neurons output layer consists of a neuron. BP neural network approach to learning for guided study way, also is in the process of network learning, for neural network learning as a result, the correctness of the network output must have an evaluation standard. Therefore, two in the process of learning to provide a large number of input and output model, the network will be according to the actual output and desired output of the comparison results, determine the size and direction of the error. Then, according to the direction of reduce error from the output layer through the hidden layers, and then to the input layer back propagation, and according to certain rules of error distribution. Error distribution is the process of the adjustment process of connection weights coefficient. Again at the same time, the back propagation process, until the error is reduced to tolerable range, or to set the number of training in advance, the BP neural network training process is finished. The learning algorithm called the error back propagation algorithm is a kind of error function gradient descent learning method. The characteristics of the BP neural network are non-linear mapping ability, classification and identification and fault-tolerant.

4 Results and Discussion

The raw data records included in Excel format, and the data require to establish a database, using statistical knowledge, mathematical statistics method, using Excel and SPSS statistical software for data acquired routine statistical analysis, access to relevant data analysis result.

Using SPSS for Windows 17.0 for data processing, as part of the normal statistical data does not match the law, it can't be used once the majority of the researchers used a statistical test for independent samples t, through statistical expert recommendations, the study recommended nonparametric test for two independent samples test, so in simple reaction time measured by the Kolmogorov - Smirnov Z test, the placement is determined when using Mann - Whitney U rank test (Tables 2, 3, and 4).

Table 2. Professional and amateur statistical left thumb simple reaction time

	N	Average (ms)	Standard deviation	Kolmogorov-Smirnov Z	Monte carlo Sig.
Professional	20	217.93	1.29673	0.443	0.721
Amateur	20	215.57	1.05001		

Table 3. Professional and amateur statistical right thumb simple reaction time

	N	Average (ms)	Standard deviation	Kolmogorov-Smirnov Z	Monte carlo Sig.
Professional	20	217.5	1.21233	0.289	0.951
Amateur	20	212.3	1.07901		

Table 4. Diagnostic Evaluation Index System

	Goal average	Utilization rate (%)	Fielding errors (%)
Professional	273	83	27
Amateur	159	56	48

Artificial Intelligence diagnostic methods for table tennis professional athletes and amateur athletes' diagnostic analysis and comparison of diagnostic results showed in Fig. 3. As we can see, the professional group of scoring rate and usage were shown high diagnostic value, indicating the important role that technology plays in elite table tennis players in the technology. Professional Group placement judgment in the use of significantly higher than the amateur group, which conceded rate, is low. Professional group subjects were to have some ability to predict the ball judgment, which were tested in peacetime training games are inseparable, trained and specialized technology itself has a certain ability to comprehend, it can slow the action in the scene quickly combined with his special knowledge and experience to adapt. The amateur blind eye on the ball and then make a judgment, there is no solid foundation and excellent spot basic ability to respond, so the amount of information in the process of gradual reduction of longest time the reaction was judged.

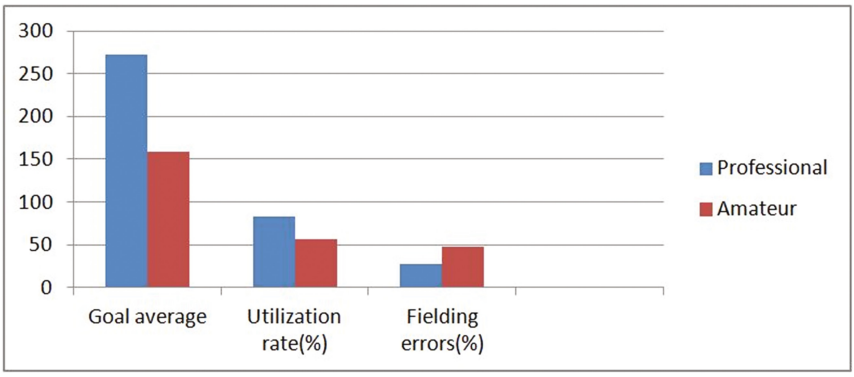

Fig. 3. Diagnostic evaluation index system

5 Conclusions

In this paper, we analyzed the current status of research on the placement judgment of table tennis by literature method, and analyzed the main influence of the athletes determine the placement of prejudging the competitors. In the experimental stage, recorded and analyzed game data of professional group and amateur group, used Artificial Intelligence to diagnose it, the results showed that due to the long athletes training and competition experience, professional group has some experience of fall point judgment, they can make better prediction and reduce the rate conceded, they also have obvious technical features; amateur group, by contrast, they intuitively judge the ball and stare at the ball, lack of ability to judge correctly. About the reaction time and accuracy, professional group is better than an amateur.

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Application of Distributed Artificial Intelligence in Network Teaching

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Abstract. With the rapid development of modern education, the current school teaching model needs to be improved and perfected to meet the needs of modern teaching. In order to improve the quality and efficiency of network teaching, it is an effective way to adopt the distributed intelligent network teaching system. In this paper, based on the definition and classification of distributed artificial intelligence (DAI), the network teaching system based on intelligent Agent technology was introduced, and the distributed artificial intelligence was applied in the intelligent network teaching platform of Distance Education and the corresponding fuzzy transform model combining with multi-agent system (MAS) and mathematical theory was established, and a network teaching system based on Agent technology was constructed. Finally, a university was taken as a study case, the evaluation of the effectiveness of network teaching based on distributed artificial intelligence technology was analyzed and studied, and by comparing the traditional teaching system with the effects of teaching evaluation of the DAI network teaching system, it can be found that the network teaching system can be optimized by the distributed intelligent technology, so DAI technology has an important role in the network teaching system.

Keywords: Network teaching · Distributed artificial intelligence · Multi agent system

1 Introduction

The researches of intelligent Agent theory and technology originated from distributed artificial intelligence (Distributed Artificial Intelligence, DAI). Agent is a software entity that can study independently and adapt to the environment. Its characteristics include autonomy, re-activity, cooperation, openness, communication, mobility and so on. The Agent can take action to achieve a set of predefined goals or tasks by sensing information in itself and in the environment [1]. The Multi Agent system is composed of a number of independent Agent, each Agent has its own responsibilities, and through the communications with other Agent it can obtain information to cooperate with each other to completely solve the whole problem. Compared with a single Agent, multi Agent system is able to complete more complex and extensive features. With the establishment of the nation's modernization and the lifelong learning system, the distance education in our country are going into a new stage of rapid development [2].

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However, in the face of many problems and difficulties in the practice of distance education, how to use the new technology to raise the level of modern distance education is a historical and inevitable problem for the distance education workers. The research and application areas of artificial intelligence and artificial intelligence science from the birth are closely related to education [3]. AI in essence is to let the computer accept education and improve the science and technology of intelligence, and its research results can be applied to the field of education to enhance the efficiency of education and produce a new teaching model. In the background of emphasizing exploration and innovation, interdisciplinary integration, knowledge integration and technology integration, how to introduce the latest technology of AI and use the latest achievements of AI to raise the level of education is a significant and innovative engineering for distance education. From the point of view of the current development trend, the influence of artificial intelligence technology in modern distance education is growing, and modern distance education already peeps into the new era of intelligent clues [4]. Distributed artificial intelligence (DAI) mainly studies that how the distributed intelligent system to solve the problems in a logical or physical way. The DAI system has the following characteristics: data, knowledge, and control of the system are distributed in both logic and physics; Each solution mechanism is interconnected by a computer network, and the communication cost is much lower than that in the process of solving the problems; Institutions in the system can cooperate with each other to solve the problems that a single institution can solve difficultly or even cannot solve [5]. The implementation of DAI system can overcome the weakness of the original expert system and learning system and greatly improve the performance of the knowledge system. The main advantages are as follows: improving the ability and the efficiency of solving problems, expanding the scope of application, and reducing the complexity of the software.

2 Background

2.1 Application of DAI in the Intelligent Network Teaching Platform of Distance Education

The main roles of Agent in the distance education network teaching platform are: dynamical tracking process and real-time monitoring, teaching and learning behavior analysis, information retrieval and filtering, collaborative learning and intelligent reasoning and so on. Through the application of this technology application, it makes remote teaching platform use intelligent agent technology to realize students' autonomous learning behaviors and behavioral counseling supervision, and according to the students' learning, progress and results, they are given specific guidance, which provides intellectual support for the counseling of teachers. Intelligent agents can be useful for teaching, managers, learners, monitors, evaluators, guides, assistance and so on to assist the remote learners to complete the study. The application of intelligent agent technology in the distance education network teaching platform provides the quality assurance and technical support for the distance education in a certain sense [6]. Figure 1 is the environment of network teaching based on artificial intelligence.

Fig. 1. Network teaching environment based on artificial intelligence

DAI can be divided into two basic research areas: Distributed Problem Solving (DPS: Distributed Problems Solving) and Multi-Agent system (MAS: Multi-Agent System). DPS studies a given problem, and how to assign the task to a group of modules or nodes so that each node can share the knowledge of the problem and the answer is also its duty [7]. Distributed problem solving is based on the cooperation of distributed and loosely coupled knowledge source. These knowledge sources are distributed on different processing nodes. If the single source of knowledge cannot solve the problem, it is necessary to make decisions on the cooperation of knowledge sources and the sharing of information. Decentralization refers to that control and data are distributed without global control and global data [8]. MAS mainly studies the coordination of the behaviors of agents and how to coordinate their knowledge, goals, skills, and mutual planning with a group of autonomous Agents and take actions to solve problems. Agent in MAS can have a global goal or have an independent goal related to their own. Like the module in the DSP system, the Agent in MAS must share the knowledge of the problem and the answer and follow the coordination process between the Agent behaviors.

The basic characteristics of the DAI system are shown in Fig. 2:

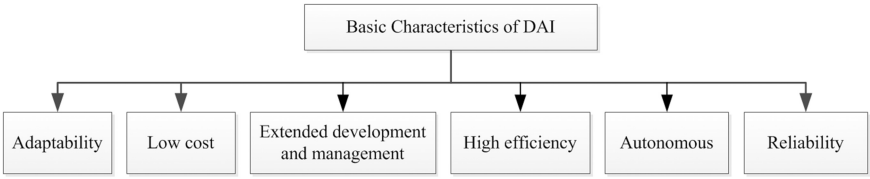

Fig. 2. Basic characteristics of DAI system

Adaptability: logical, semantic, temporal and spatial distribution of the DAI system can provide a variety of choices for different environments and it has a greater ability to adapt to different environments. Low cost: DAI system can contain many simple computer systems with low cost. Extended development and management: each unit in the DAI system can be independently developed by a specific domain expert, and the DAI system can be expanded or integrated with existing computer systems.

High efficiency: parallel processing can improve the speed of calculation and reasoning. Autonomy: for the purpose of local control and protection, the unit in the DAI system is isolated. Reliability: The DAI system is more reliable than the centralized system because of the redundancy and mutual checking [9]. The basic problems of DAI research include: how to describe, decompose and assign tasks and how to solve the integrated problem between groups of agents. The second one is about how to make intelligent communication and interaction and use all kinds of language and communication protocols, communication contents and time. The next is about how to ensure consistency in the interactions of decision, action, and the adjustment of local decisions and the impact of the overall situation. Fourth one is to coordinate between single agents, how to express and derive the behaviors, planning and knowledge of other agents and push the state of the coordination process are involved. The fifth one is how to identify and coordinate the differences of views and intentions in the cooperation between the agents and how to synthesize a unified view and consistent results.

2.2 MAS Technology

MAS (Multi-Agent System) is an important research direction that has been developing rapidly in recent years and it has been applied in the field of scientific research and engineering. MAS mainly studies how to coordinate the intelligent behaviors of multiple Agent in the logical or physical way, so as to realize the complex problem solving. There are a number of components, and it is a loosely coupled network of complex problem solving, which often is used to solve those problems that cannot solve or can be solved difficultly. Each one of the MAS is a physical or an abstract entity, which has part of the information or ability of solving the problems, and it can act on it or the environment, communicate with others, coordinate with each other and work together to achieve a predetermined goal. Relationships can be cooperative, but there are also competitions. This fully reveals many common characteristics of human society and the potential social significance of the study. In human society, there is a certain connection between individuals, and it is the connection that makes the individual form a human society, so that the individual becomes a social and attributed person. Also, several persons stacked together, which will always be a few independent individuals, only through mutual coordination and cooperation, can they form the system of a certain function of operations. As an integral part of the environment, they must be active in dealing with their own internal affairs and the distribution of the business environment. The relationships between them and the environment are the same with people in a society, they not only solve their own affairs, but also assume the responsibility of society as a member of society [10]. Therefore, the application of Agent is mainly in the form of multiple collaboration. Just like the general intelligence of the society has been better than any individual, the solution of the cooperative system is far more than a single system. Agent's intelligence is reflected in the ability of effective cooperation in achieving the common goal, so, the multi coordination and cooperation are the core problems of researches.

3 Methodology

3.1 Fuzzy Transformation Model in Intelligent Network Teaching

A can be represented as a fuzzy set, which is set: $A = (a_1, a_2, \ldots, a_n)$, among the $U = (x_1, x_2, \ldots, x_n)$, ai is corresponding membership degree $\mu_A(x_i), i = 1, 2, \ldots, n$. Fuzzy vector can be regarded as a fuzzy matrix with one line, which can define fuzzy transformation. Matrix $A = (a_{ij})_{m\times n}$ and column vector X, so $Y = AX$. And Y is a column vector, and elements of Y are calculated by this way:

$$y_i = \sum_{k=1}^{n} a_{ik}x_k (i = 1, 2, \ldots, m). \tag{1}$$

So

$$(\, y_1 \quad y_2 \quad \cdots \quad y_n \,) = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \bullet (\, x_1 \quad x_2 \quad \cdots \quad x_n \,) \tag{2}$$

Assuming a fuzzy matrix R and a fuzzy vector X:

$$X = (x_1\, x_2 \cdots x_n), 0 \le x_i \le 1\ (i = 1, 2, \ldots, n) \tag{3}$$

$$R = (r_{ij})_{m\times n} (0 \le r_{ij} \le 1) \tag{4}$$

Y, in fact, is the synthesis of fuzzy vector X and fuzzy relation R matrix, formula $X \bullet R = Y$ is called fuzzy transformation.

If:

$$X = (0.2, 0.5, 0.3) \tag{5}$$

$$R = \begin{pmatrix} 0.1 & 0.5 & 0.1 & 0.2 \\ 0.3 & 0 & 0.4 & 0.3 \\ 0.5 & 0.1 & 0.2 & 0.2 \end{pmatrix} \tag{6}$$

The synthesis result Y is

$$Y = X \bullet R = (0.2, 0.5, 0.3) \bullet \begin{pmatrix} 0.2 & 0.5 & 0.1 & 0.2 \\ 0.3 & 0 & 0.4 & 0.3 \\ 0.5 & 0.1 & 0.2 & 0.2 \end{pmatrix} = (0.3, 0.1, 0.4, 0.2) \tag{7}$$

In the construction of the complex student model, the introduction of the principle of fuzzy transformation makes the evaluation of students' cognitive level and learning strategies more scientific [11].

3.2 Standardization Process of Network Education Platform

With the continuous maturity and progress of the standards, the operability and the implementation of the standards have been improved significantly. Moreover, the international standardization organizations also strengthen the contact and communication, such as ISO, IMS, AICC, they have a close contact. Many studies have also begun to focus on how to coordinate the differences between these different standards. And at the same time, with the gradual popularization of E-Learning in the global scope, the voice and demands of letting E-Learning system share learning resources and interoperability are growing. With this kind of background, the educational technology standard also gradually developed from the theory to the practice [12]. In the different development stages of the network teaching platform, the network teaching platform focuses on different E-Learning requirements. Therefore, different types of educational technology standards and norms are needed to meet the needs of different applications. Figure 3 describes the standardization process of the network teaching platform: In the early stage of the network teaching platform, its main function is to provide the management of digital learning contents (CMS stage). Correspondingly, the formulation and application of standards are mainly focused on the description and organization of learning resources and contents. The meta-data standard, which provides a unified data format for describing the resources of different systems, is to describe the attribute name and value of resources. Only uniting the data format, can the system understand each other information and it can share the resource. The meta-data standards we know are LOM Dublin, Core IEEE of Dublin, etc. This is the earliest stage of the development of learning standards, and through the implementation of these standards, a variety of teaching resources can be convenient to import and export in different teaching platforms, so as to achieve the most primary resource sharing.

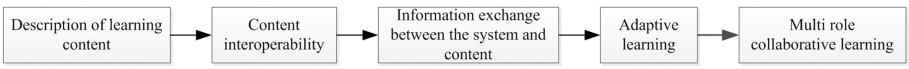

Fig. 3. The standardization process of network teaching platform

3.3 Network Teaching System Based on Agent

The introduction of Agent technology in network teaching can play a very important role in the following areas: It can establish a collaborative learning environment of network learning by using the social nature of agent, and learners complete collaborative learning through agent collaboration mechanism and teachers and students can exchange information, at the same time, teachers can also make collaborative teaching; The distribution of agent can unify the teaching resources and enhance coordination and reusability, in order to achieve different software, data exchanges and collaborative work between software in the heterogeneous network, operating system and machine environment; Using the autonomy of Agent, it can dynamically track learning behaviors, and according to the learner's learning situation, it puts forward suggestions

to the learners and automatically organizes learning contents. According to different functions, the main Agent of the network teaching system are management Agent, teacher Agent, student Agent, resource Agent, question and answer Agent, examination Agent and other categories [13].

Management Agent: Agent is responsible for the management of teaching issues related to the decision-making, teaching and the Agent control and supervision of other issues. Management Agent is composed of the controller, the teaching inference engine, the knowledge base, the student model base and the communication module. The controller has the function of dispatching, directing and coordinating of the whole teaching task. Teaching inference engine comprehensively uses relevant information from the knowledge of knowledge base and the student model base, and according to the control strategy of the various problems encountered in the teaching process of reasoning, it arranges the teaching contents and adjust the decisions of teaching procedures and methods to provide the optimal solution. There are control knowledge, problem solving knowledge and communication knowledge, this knowledge is not static, and it can be added and updated with the problem. The database of student model records the student's information and the scope of the student's knowledge. Communication module is responsible for communicating with other Agent, reflecting the interaction and cooperation between the Agents. Intelligent tutoring system stores the domain knowledge and the corresponding teaching methods, which can teach students individually, and according to the understanding level of knowledge of students to automatically adjust the teaching methods and the teaching speed, which in a certain extent simulates the software system of human experts in teaching the teaching activities [14]. An Intelligent teaching system usually consists of three main parts: the domain knowledge base, the student module and the inference engine. The overall structure of the system is shown in Fig. 4.

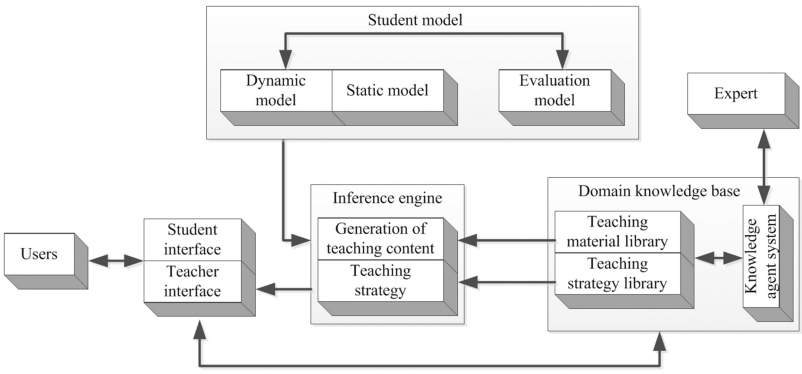

Fig. 4. Overall structure of intelligent teaching system

4 Results, Analysis and Discussion

Researches and evaluations of the effectiveness of the network teaching in a school are made, which mainly emphasizes to give priority to the quantitative researches and supple the feedback and suggestions. In "curriculum design and development course of network", we made use of the investigation and statistics of the network learning platform to make a survey, and the first batch of 90 students conducted a questionnaire survey, 47 the number of valid questionnaires was recovered, the recovery rate is 52%. Tables 1, 2 and 3 is the students' satisfaction, teaching effect and learning achievement of this course [15]. To compare the evaluation results of face-to-face teaching, we adopt the statistical evaluation method that has been used in professional education in the college classroom teaching of Hong Kong University, calculating the average percentage of each evaluation problem. The formula is: [the number of people (very satisfied/agreed very much) × 100 + the number of people (satisfied/agreed) × 75 + the number of people (OK) × 50 + the number of people (Not satisfied/disagree) × 25 + the number of people (very dissatisfied/extremely dissatisfied) × 0]/ the total effective number (does not include the number of people who choose not to apply). The average percentage of the evaluation results was interpreted as: 0–39.9% means "fail", 40–49.9% means "OK"; 50–59.9% means "satisfaction"; 60–69.9% means "good"; 70–74.9% means "very good"; 75–100% means "excellent".

From Tables 1, 2 and 3 we can know that the satisfaction, teaching effectiveness and the effectiveness of students based on distributed artificial intelligent network courses get "excellent" in the classroom teaching evaluation. In which the satisfaction rate of the quality gets 87 points and teaching effects reach 84 points, and the effects of learning reach 82.8 points, and evaluation of "this course is worth learning" achieves a high score of 92. This performance is much higher than the average score of the college classroom teaching.

Table 1. The degree of satisfaction of the students (%)

	Very satisfied	Satisfied	Commonly	Dissatisfied	Extremely dissatisfied	Not applicable	Average
Website design	53	34	9	4	0	0	84.0
Teacher lectures (video)	57	39	2	2	0	0	87.8
Teachers' guidance	68	26	4	0	2	0	89.5
Instructional design	57	35	4	2	0	0	85.8
Network independent learning materials	47	43	10	0	0	0	84.2
Network learning environment	51	36	9	2	2	0	83.0
Quality of the course	58	36	4	0	2	0	87.0

Table 2. Evaluation of the teaching effect of the students on the course (%)

	Very satisfied	Satisfied	Commonly	Dissatisfied	Extremely dissatisfied	Not applicable	Average
The teacher's lecture rhythm is moderate (video)	68	30	2	0	0	0	91.5
The teacher has a good knowledge of the curriculum	79	19	2	0	0	0	94.3
Tutors have abundant knowledge of curriculum	66	28	6	0	0	0	90.0
Tutors answer clearly	62	32	6	0	0	0	89.0
Guidance teachers stimulate students' online discussion	63	24	13	0	0	0	87.5
Guidance teachers stimulate students interest in learning	53	36	9	2	0	0	85.0
Tutors can help students learn	53	36	9	0	2	0	84.5
Teaching effect of this course is good	51	40	9	0	0	0	84.0

Table 3. Evaluation of students' learning performance in the course (%)

	Very satisfied	Satisfied	Commonly	Dissatisfied	Extremely dissatisfied	Not applicable	Average
This course has a good learning effect	45	43	10	2	0	0	82.8
This course is worth learning	66	32	2	0	0	0	92.0

5 Conclusion

With the extensive application of artificial intelligence technology and the rapid development of the network teaching system, the network teaching system based on the distributed artificial intelligence technology has become a hot research topic [16]. The study is conducive to the promotion of the efficient and sustainable development of modern teaching. This paper establishes a network teaching system based on the distributed artificial intelligence technology, which not only provides a theoretical basis for solving the distributed problem, but also provides a technical platform and model for network teaching. Through the experimental analysis of the teaching achievement of a school that based on the traditional teaching mode, the advantages of distributed artificial intelligence network teaching system are obvious, and in the aspects of teaching, it has good effects, so the distributed artificial intelligence technology has a greater role in promoting the modern education. But the relative researches on the

further integration and the future development direction of artificial intelligence and network teaching are not enough, and on the basis of more practice and researches, the system model of modern teaching should be optimized and perfected and the high efficiency and sustainable development of network teaching will be realized.

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Research on Personalized Recommendation of Electronic Commerce Website Based on Text Mining

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Abstract. With the growing popularity of electronic commerce, for enterprises to enhance the competitiveness, enterprise decision makers and active innovation, to build a distinctive, individualized and user characteristics of e-commerce network platform, e-commerce personalized recommendation was thus born. Enterprises make use of the data mining technology, search, record, analysis server, browser the user's browsing history and purchase records, selected users a sense of interest from the market information, provide differentiated network marketing strategy. Presented in this paper based on text mining e-commerce website personalized recommendation technology is the A, this paper through the comparison of text mining and Web Mining Technology Analysis of the text mining technology of personalized recommendation technology of precision, which information data of the study of mining technology has great reference value.

Keywords: Text mining · Personalized service · Electronic commerce · User modeling

1 Introduction

E-commerce, personalized recommendation service is referred to the enterprise, according to every customer's age, occupation, income, family structure and so on personal characteristics, and customer purchase ability, purchase intention and purchase preferences and buying habits and other factors, according to the specific information customization, accord with the demand of each customer's unique products and services to (see Fig. 1).

Chen L C proposed a personalized recommendation method based on similar pattern clustering in 2013, which is a good reference for text mining technology in the personalized recommendation algorithm of e-commerce technology [1]. In 2011, You W proposed a recommendation algorithm based on the association rules based on the extended matrix [2]. Chen Y L in his paper proposed using a Markov model for the calculation method of sequential patterns, then gives a detailed sequence model of the personalized recommendation model, the algorithm can by finding the sequence of frequently used and the current user browsing of automatic matching (see Fig. 2), and generate the page recommendation [3]. Lee, Y H in his paper uses the inductive logic to

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Fig. 1. Global e-commerce

Fig. 2. E-commerce operation

learn the relationship between web pages, learning rule extraction algorithm, and use the Bias theory to extract the contents of the data classification [4]. Ma B pointed out the key points and the solution of text mining, and pointed out that the characteristics of the data mining are the foundation of text mining [5].

This paper points out that the electronic commerce website personalized recommended service data mining definition, object, process and implementation method of and the web mining technology in terms of information accuracy of modeling contrast, is derived based on the electronic commerce website text mining in personalized recommendation services, fine quasi is more outstanding.

2 Present Scenario

2.1 Definition of Data Mining in Personalized Recommendation of Electronic Commerce Website

Text mining is to extract information and knowledge from a large number of miscellaneous, irregular, fuzzy and random data, text, which hidden in one of them, but it is potentially useful information. Text mining in electronic commerce website is the application of mining in the field of electronic commerce website product information processing. Specifically, using text-mining technology carries on the excavation to the customer access information in the network, customers browsing behavior and access mode, to find out the customer's interest, hobbies, and other useful market information, to provide a basis for personalized customer service. Because of the particularity of e-commerce website information, text mining has added new features to the traditional data mining. First of all, the text mining is a large number of heterogeneous distribution of documents, each text data sources are heterogeneous; secondly, the document itself is semi structure or non-structure, and the lack of machine understandable semantic, making mining more complexity. Therefore, the text mining in e-commerce website is a new development stage of the network information processing technology. As shown in Fig. 3 for the moment the most popular, the largest number of users of electronic commerce website: eBay network.

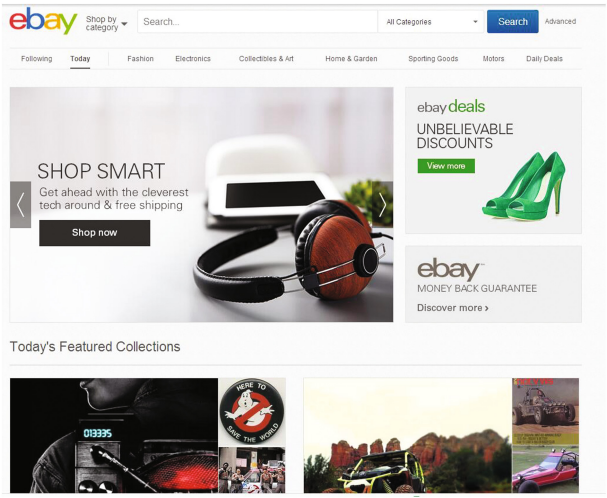

Fig. 3. eBay

2.2 Text Mining in Personalized Recommendation of Electronic Commerce Website

Text mining in personalized recommendation of an electronic commerce website personalizes service information, which is to record the user's behavior, habits,

preferences and other information. Therefore, the understanding and acquisition of user needs, interests and hobbies is the key to the success or failure of personalized recommendation service for users. Currently, access network user information, there are two: through man machine interactive mode to obtain the user's information, that is, the user online fill in the request and send a form of their information needs, user requirements very carefully fill in their own individual needs to find expression. The advantages of this method is can accurately obtain the user's demand, the disadvantage is poor initiative and received feedback limited and cannot reflect the changes of users' information needs. Two is through the record of user information behavior to dig, to obtain their needs, interests and hobbies; this method is active, dynamic, and timely understanding of user information and changes in the situation. Personalized recommendation services are recorded in the form of server data, query data, online store data, customer registration information and so on [6, 7].

3 Methodology

3.1 E-Commerce Personalized Recommendation Model Based on Text Data Mining

Based on text data mining e-commerce, personalized recommendation consists of six compositions: data collection module, preliminary data processing module, data storage module, the depth data mining module, user access and recommendation module and an electronic commerce website based on mining the content recommendation. Through the collection of text database, text, record usage and access records on the left, the formation of data collection; data collation module to the initial classification of the data acquisition of the library data, such as delete the redundant information in the data. Preliminary data all affect the quality of classification mining effect and quality; data storage module after finishing the preliminary after the data is stored in the user database. The classification of data in the database, generally divided into objective information, understanding information and expression of information. Through the classification of information recommendation technology for the realization of data pave the way; the depth of the data mining module in a depth mining engine using statistical analysis, association rules. For example, clustering analysis, sequence pattern, mathematical statistics method, to discover user browsing rules, and through the model. The analysis carries on the induction analysis, according to the practical application. Through observation and selection, conversion of the statistical results, the discovered rules and model for knowledge, after screening by e-commerce behavior effect model used to guide the actual electronic commerce website. According to the mining results to adjust the recommendation module according to the data mining of the user of the product the demand and interest of e-commerce website, user access to the recommendation engine module set in the text in the server. It will present user browsing activity and browse the web page recommendation aggregation combined consideration, generate the corresponding recommendation. Then add in the e-commerce page the user recommended set of pages, and then transfer to the client through the server browser, providing real-time personalized service for users.

3.2 Analysis of E-Commerce Website Personalized Recommendation Based on Text Mining

Personalized e-commerce sites recommended by data mining collection, processing, summarizing the user information, then carries on the classification to the user information, analysis, set up a user model, in the user model based on pattern discovery and analysis, provide personalized recommendation service. At present, the e-commerce website personalized recommendation service usually includes four levels: user information collection, user modeling module, personalized recommendation module and user module. Its structure shown in Fig. 4.

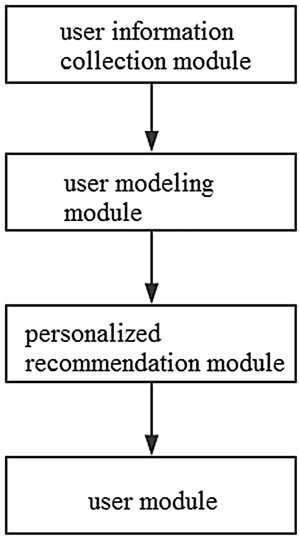

Fig. 4. Electronic commerce personalized recommendation service structure

3.3 Electronic Commerce Personalization Recommendation Realization Method Based on Text Mining

Personalized recommendation is an important method and a way to realize the personalized service system and it is the foundation and the source of the personalized recommendation service. Personalized recommendation service is through text data mining techniques reveal a user demand, too, according to the user's preference to recommend to the user's favorite products and when the system product library and user interest profile changes, recommendations sequence will change automatically. Commonly used personalized recommendation service based on the contents of the recommendation technology, based on the rules of the recommended technology, collaborative recommendation technology, hybrid recommendation technology, etc. Table 1 shows the text mining techniques used in the personalized recommendation.

Table 1. Text mining in different personalized recommendation services

Mining recommendation method	Data acquisition	Data preprocessing	Pattern discovery and usage
Content based recommendation	Cookie	User identification	Classification
Rule based recommendation	Client user information	User session identification	Association rules, sequential pattern discovery
Collaborative recommendation	Server browsing history	User session identification	Classification
Hybrid recommendation	Server data, client	User session identification	Sequence pattern discovery, association rules

4 Result Analysis and Discussion

According to the proposed text-mining model, the training set modeled, and the results of the four indicators are the average of the results of different test sets according to the experimental design. Each group of test set of experiments, text mining and traditional digital mining algorithm calculated at the same time, the selection of the contrast of the two because, in personalized recommendation has been good application and approval, recommended model proposed in this paper and it compared to direct data compared. It found that the pros and cons of the recommended model proposed in this paper.

Through experiments, this paper obtains the precision measurement of the personalized recommendation system that is to measure the accuracy of the index, as shown in Fig. 5.

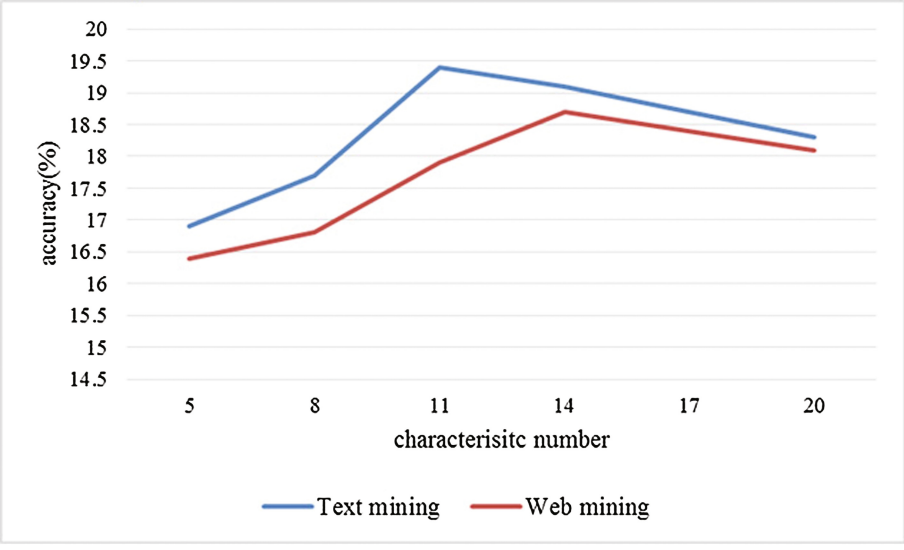

Fig. 5. Accuracy rate comparison chart

The trend chart obtained from Fig. 5, with the increase of the number of feature entries, the accuracy evaluation index showed a trend of first increasing and then decreasing. Precision in feature term in 5 and 20, text mining and web data mining calculated mean value was flat state; text mining first reached its peak value. Decrease slows and Web Data Mining in flat, the overall value higher than the web data mining technology. Explain the text mining model technology in the precision rate is better than that of Web data mining technology.

5 Conclusions

This paper introduces to electronic commerce website data mining, based on text mining e-commerce, personalized recommendation model, and analyzes how text mining technology is applied to the electronic commerce website personalized service system, to collect user information, user modeling, personalized service recommendation phase is constructed. In addition, through the comparison with WEB data mining with the experimental results, it concluded that text mining in e-commerce personalized recommendation has a stronger accuracy. Due to the conditions of the restrictions, the paper still has much room for improvement, such as only through the user use to collect data on the effect of narrow coverage, the better method is to consider a variety of factors that need to be further researched.

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Design of Intelligent Evaluation System of Physical Education Teaching Based on Artificial Intelligence Expert Decision System

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Abstract. Evaluation of PE teaching theory as both cross discipline characteristics of social science and natural science attribute has the macro and micro points in terms of the research scope. And physical education teaching evaluation usually refers to the micro sports teaching evaluation. The continuous development and application of artificial intelligence technology, provides a new perspective for the re-evaluation and setting of physical education for schools and teachers. Based on this, sports teaching intelligent evaluation system based on artificial intelligence expert decision system was analyzed and studied. Based on the discussion of the present situation of the sports teaching evaluation system, the definition and structure of the artificial intelligence expert decision system were achieved. The weight of the evaluation index of the intelligent evaluation system for physical education teaching was determined. In addition, the design ideas and functions were analyzed and studied. The results show that sports teaching intelligent evaluation system based on artificial intelligence expert decision system provides a new development strategy for the application and progress of modern PE technology, and also provides theory support and guidance for the further development of the science and education technology.

Keywords: Artificial intelligence · Expert decision system · Physical education · Intelligent evaluation system

1 Introduction

With the continuous development of science and technology and the continuous progress of humanities and natural science, more and more scientific results have emerged. Nowadays, the aim of each subject education has been to face the modernization, cosmopolitanization and future oriented, in addition to serving the cause of modernization, modern educational ideas, concepts, and the application of modern educational technology is required. The teacher evaluation system as an important part of the teaching of physical education is able to assess the quality and feed back the results of the teaching of physical education. Therefore, the scientific and reasonable evaluation system of teaching has become an important demand of physical education, and the

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evaluation of sports teaching made by one-sided, superficial and simple teaching evaluation is usually not satisfactory. When achievements of science and technology are rapidly entering the field of physical education, the intelligent evaluation system based on the artificial intelligence expert decision system bears. This new teaching evaluation system has brought changes of PE teaching content and teaching methods, and it has updated the physical education ideas and teaching modes, which has caused the reform of the physical education system and organization form.

Zhang Qiao [1] proposed that physical educators should change the traditional concept of teaching evaluation, use sports teaching intelligent intelligence system based on the artificial intelligent expert decision system to strengthen the intelligent evaluation of students, and conduct extensive research deeply on the basic theory of comprehensive intelligent evaluation for students. Ye Zhen [2] found the appearance of an expert decision system based on artificial intelligence brought attention to individual characteristics which stimulated the potential of students, taught students in accordance with their aptitudes using a variety of evaluation methods. Zhang Wei [3] deeply analyzed and studied the application of artificial intelligence technology in modern physical education technology and its development prospect, and put forward the corresponding development strategy. Ma Shengyong [4] emphasized that it's very important to combine the organic combination of evaluation of teachers, students' self-assessment and students' mutual evaluation, and put forward some corresponding strategies for the use of the artificial intelligence expert decision system in the modern education technology.

In order to establish a comprehensive, scientific and reasonable evaluation system of physical education, the intelligent evaluation system of physical education is analyzed from the point of view of the artificial intelligence expert system in this paper. The remainder of this paper is organized as follows. In the second chapter, the present situation of PE teaching evaluation system is discussed. In the third chapter, the definition and structure of the artificial intelligence expert decision system are studied, and the design ideas of the intelligent evaluation system for the teaching of physical education are analyzed. The fourth chapter focuses on the determination of the evaluation index weight of the intelligent evaluation system, and summarizes and defines the functional realization of the intelligent evaluation system of physical education teaching. In the fifth chapter, the research process and the results are summarized.

2 State of the Art

The research object of the intelligent evaluation system of PE teaching based on artificial intelligence expert decision system can be divided into two aspects: macro and micro [5]. Macro sports teaching evaluation means that conduct research all teaching activities related to the evaluation problem in sports activities, such as the activities with the nature of teaching in social physical education and competitive sports training. The evaluation of micro physical education only includes the evaluation of physical education in schools, which generally refers to the evaluation of sports teaching. According to the microcosmic meaning of PE teaching evaluation, its specific meaning can be subdivided into broad sense and narrow sense [6]. The general evaluation of

physical education teaching is the evaluation of all factors that affect the teaching activities, including the evaluation of physical education courses and the evaluation of teachers, students, teaching plans and teaching materials. Teaching evaluation of PE in a narrow sense general refers to the evaluation of physical education curriculum. From the perspective of modern quality education, it can be seen that the evaluation of physical education teaching should be able to do all the factors in teaching, all-round, three-dimensional and comprehensive evaluation.

With the continuous reform and progress of society, deepening development of science and technology and interdisciplinary integration, physical education teaching evaluation methods and theories are both in the ongoing development and improvement, and gradually become a comprehensive and complete new subject [7]. In the whole physical education teaching evaluation system, evaluating the object of evaluation and value judgment according to a certain evaluation target and evaluation criteria has a certain role in guiding the object of evaluation. The goals, targets, criteria and weights of the evaluation results have certain significance to the evaluation objects. Sports teaching evaluation system also has a considerable diagnostic role. In the specific sports teaching evaluation process, evaluators can use a variety of evaluation methods to collect and analyze the data of the object, judge their object arrival and value match according to the evaluation criteria, search for the causes of the problems, and improve the ways and measures. Sports teaching evaluation also has the incentive function to make the object evaluated produce excited emotion cheer up and dance to fight, which basic purpose is to encourage the evaluation object to improve according to the evaluation diagnosis [8].

3 Methodology

3.1 Artificial Intelligence Expert Decision System

Artificial intelligence is a cross discipline among the three subjects of technical science, natural science and social science. As a branch of computer science, the concept can be divided into two parts, the “artificial” and “smart”, which respectively defines the pre-operation of relevant technology and the intelligence system that uses thinking ability related to human intelligence to study, including logical thinking ability, image thinking ability and creative thinking ability. DSS (Decision Support System) is an information processing system based on a computer that uses data, knowledge and models to solve semi-structured or unstructured problems in the man-machine interactive way and help decision makers to make effective decisions. DDS provides decision makers with the environment to establish models, analyze problems, simulate decision-making processes and programs, and can make calls to a variety of analytical tools and information resources to improve the quality and level of decision makers [9]. ES (Expert System) are an intelligent computer program, which contains reasoning and knowledge, which contains the experience and knowledge of the level of expertise in a particular field. It can be used to solve problems in a certain area by using methods of human experts to solve the problem. By combining DSS technology with ES

technology, the expert decision-making system is obtained, also known as an intelligent decision support system (IDSS).

Expert decision-making system covers the process of expert system to participate in decision-making. Taking into account that the decision support system makes a quantitative analysis of the problem through the simulation of the computer as the core, it is needed to use the subjective initiative when there are some problems in the decision making, which are not accurate and unstructured. Expert decision system firstly stores, the experience and knowledge of domain experts in the knowledge base in advance, and solves the qualitative analysis of the problem in the knowledge, reasoning way in order to improve the level and intelligent degree of decision-making process.

There are three ways to combine DSS and ES in IDSS [10]: The combination of DSS and ES, DSS and ES are unified through the man-machine interaction system; The combination of KB (knowledge base) and MB (Model Library), using the mathematical model of MB as a process of knowledge to join the process of knowledge reasoning; The combination of DB and dynamic DB, a static DB in DDS provides the original data for the dynamic DB in ES, and sends the conclusion after the ES reasoning to the static DB in DSS [11–13]. The software is integrated with DSS and ES together, and the overall structure of the integrated IDSS is shown in Fig. 1.

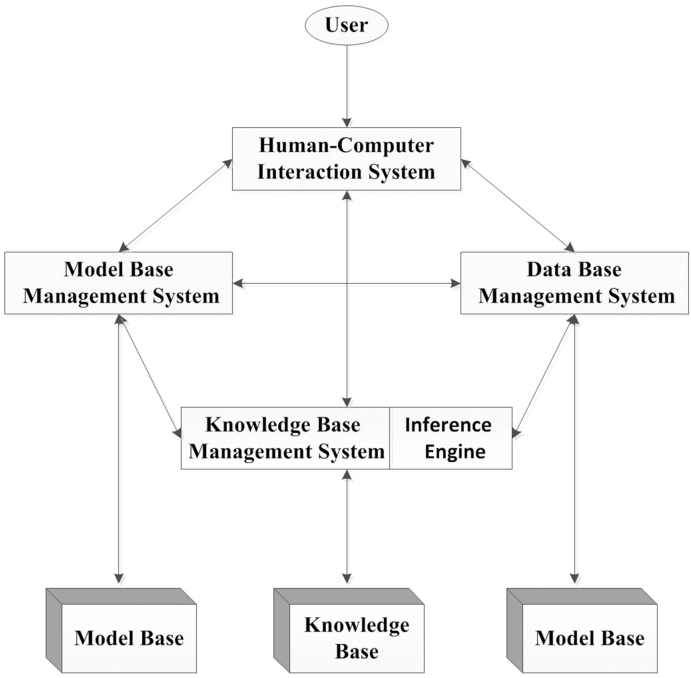

Fig. 1. Overall structure diagram of IDSS

3.2 Intelligent Evaluation System of PE Teaching

Evaluation system of PE teaching has the remarkable characteristics of structural strength, the level of complexity and amount of information and so on. As a complex system engineering, it needs to spend a lot of manpower, material and financial resources to in order to meet the requirements of standard, fast and good evaluation. The traditional manual processing method has been unable to meet the requirements, so the physical education teaching evaluation system should be computerized, and make it become a common behavior to improve the level of school physical education. When the computer network technology is skilled application, the purpose of evaluation will be achieved through the communication evaluation and thus the workload will be reduced greatly [14, 15].

The overall idea of the design of the intelligent evaluation system for physical education teaching is as follows: Firstly, realize the integration of neural network and expert system, make the neural network embedded in the expert system as a function call and as the tool for collection of information or knowledge acquisition of expert system, and transform the resulting knowledge into the rules and facts of the reasoning process of expert system; Secondly, combine the decision support system and the integrated neural network expert system, in order to implement the intelligent decision support system. Sports teaching intelligent evaluation system includes decision support system, intelligent human-computer interface, management subsystem of PE evaluation index system, system total control module, comprehensive evaluation system with neural network expert system, evaluation result output module, learning module and so on. The management subsystem of sports teaching evaluation index system contains index system structure module, evaluation index extraction module, integrated information, query module, database management system, center database, standard database and data dictionary; Comprehensive evaluation subsystem with neural network

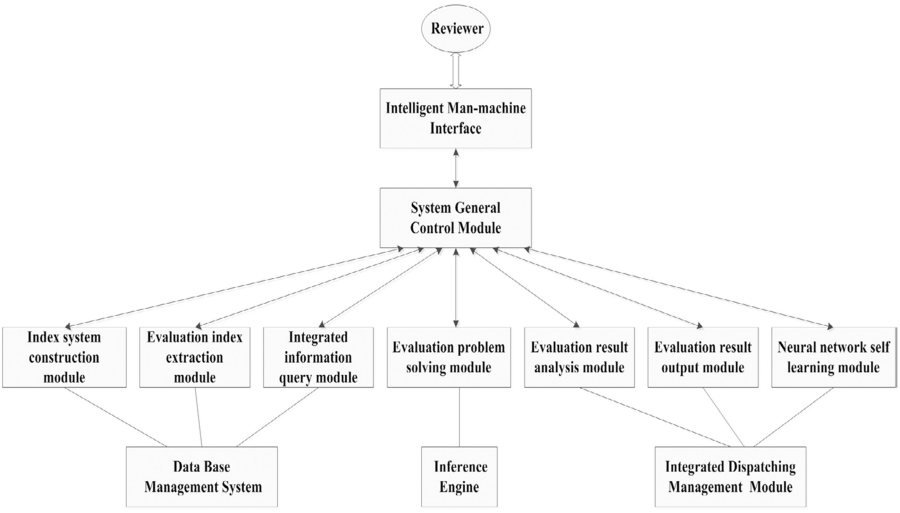

Fig. 2. Structure diagram of Physical education intelligent evaluation system

expert system is composed of the results analysis module, evaluation problem solving module, inference engine, integrated scheduling management module, knowledge base management system, neural network knowledge base, system knowledge base, model management system, model base, method base, sample management system, sample database, and evaluation analysis results database. The structure of the intelligent evaluation system of physical education teaching is shown in Fig. 2.

4 Evaluation

4.1 Evaluation Index of Intelligent Evaluation System of PE Teaching

Intelligent evaluation system in sports teaching has its specific evaluation indicators, including the following eight aspects: Language text intelligence, mathematical logical intelligence, visual spatial intelligence, musical rhythmic intelligence, bodily kinesthetic intelligence, interpersonal intelligence, insight introspection intelligence and naturalist intelligence. According to different investigation and evaluation objects, the determining method of the index weight of the intelligent evaluation system is varied with some limitations. The determination of each evaluation index's weight coefficient can be obtained using the Delphi method to of, which is shown in Table 1. Then use the principal component analysis method to reduce the dimension of the indicators, so as to make the whole teaching intelligent evaluation system clear and easy to understand. The contribution rate of the main components of the study is listed in Table 2.

It can be seen from Table 2, the cumulative contribution rate of the first four principal components is 81.493%, which is very close to 85%. Therefore, the first four principal components as a comprehensive indicator of our evaluation is extracted, and the results of the first four principal components are: 31.902%, 53.778%, 69.167% and 81.493%. By the first principal component analysis results, it's known that the coefficients of the variables are close with little difference in the numerical and relatively close load. The results show that the first principal component is jointly determined 8 indexes in from Table 1. The first principal component is called comprehensive intelligence factor, and it can be regarded as a comprehensive evaluation of students' learning effect. The second principal component is mainly used to evaluate the students' physical fitness and exercise technology, which is determined by the body movement index (21.876%)

Table 1. Weight of evaluation index

First-grade index	Weight
Languages intelligence	0.16
Mathematical logic intelligence	0.15
Visual space intelligence	0.07
Music rhythm intelligence	0.07
Physical exercise intelligence	0.31
Interpersonal communication intelligence	0.12
Intrapersonal intelligence	0.06
Natural observation intelligence	0.06

Table 2. Principal component analysis

Component	Initial eigenvalues		
	Total	% of Variance	Cumulative %
1	2.552	31.902	31.902
2	1.750	21.876	53.778
3	1.231	15.389	69.167
4	0.986	12.326	81.493
5	0.635	7.938	89.431
6	0.543	6.788	96.219
7	0.244	3.050	99.269
8	5.848E−02	0.731	100.00

and called movement intelligence factor. The third principal component is dominated by the intelligent index (15.389%), which is used to evaluate the intelligence of students' language and called linguistic intelligence factor. The fourth principal component is composed of two evaluation indexs: mathematical logic and interpersonal intelligence (12.326%), which main effect is analyzing the relationship between mathematical logic and interpersonal intelligence, called communication intelligence factor.

4.2 Function Realization of Intelligent Evaluation System of PE Teaching

As the main theme of the school sports work, sports teaching evaluation has the characteristics of demonstration, repeatability, visualization and so on. Combining artificial intelligence expert decision system with the evaluation system of physical education teaching not only can theoretically enrich the teaching content of physical education, change the traditional teaching mode and concept, but also guide practice from the reality, and promote the teaching reform and constantly deepening development of physical education. In today's information technology environment, sports teachers use modern intelligent technology with a new concept and theory to guide and examine the various aspects and fields of the teaching activities. The scene graph of today's sports teaching activities is shown in Fig. 3.

The analysis of IDSS architecture diagram shows that intelligent human-machine interface as an interface for interactive system and evaluators can understand questions with various forms expressed by evaluators, be able to convert all kinds of questions to understandable way, allow direct intervention of evaluators in the operation and reasoning process of the system, and transform the running results to tables or graphs in a manner that is simple and straightforward. The intelligent man-machine interface can be used to decompose the complex evaluation problem through the system control module and coordinate the various modules, which plays the role of the organization system. The required index system for the maintenance of the entire system, the formation of indicators, the original index data and other integrated information are unified maintained and managed by evaluation index system management subsystem. Evaluation index extraction module is used for generating and extracting the specified object corresponding to a specific index system, or specifying the index attribute value

Fig. 3. Physical teaching field

of the evaluation target of the index system to form the attribute value matrix related to evaluation index. Integrated information query module inquires various aspects of the specified object mainly through the conditional or unconditional query method. The database management system has the function of defining the structure of the database, controlling the data, operating the database integrity and security, maintaining and restoring the database. Comprehensive evaluation subsystem with neural network expert system is the most important part of the entire system, which can make comprehensive evaluation of the specified object using flexible fuzzy comprehensive evaluation model and neural network system. The evaluation result output module can generate all kinds of forms of tables or curves and output to the screen or printer according to the information required by the reviewers. Self-learning model based on the neural network can use the neural network to apply learning expert of sample pattern to the evaluation of physical teaching so as to constantly update and improve the knowledge reserve of neural network expert system.

5 Conclusion

The purpose of this paper is to study the connotation and construction of intelligent evaluation system of physical education teaching based on artificial intelligence expert decision system. In order to solve all kinds of problems existed in modern sports teaching evaluation system, decision support system and expert system are combined, artificial neural network based on artificial intelligence is nested in the knowledge base, and sports teaching intelligent evaluation system are designed and constructed. Research and analysis of artificial intelligence expert decision system, the structure

decomposition analysis of sports teaching intelligent evaluation system are made. The weight of all kinds of evaluation indexes of the system is analyzed, and the function realization of each subsystem is obtained. The results show that the combination of artificial intelligent expert decision system and the evaluation system of physical education teaching promotes the comprehensive application of modern science and technology in the field of sports, optimizes the sports teaching evaluation pattern and the education idea, and plays a certain role in promoting and deepening the reform and development of physical education teaching. However, study on man-machine combination of the sports teaching intelligent evaluation system is slightly insufficient. Future research should focus on that how the student's self-evaluation be in better practice on the road of man-machine combination. And the evaluation of physical education teaching should be guided form the reward and punishment to the development evaluation, and the process evaluation should be paid more attention to.

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Analysis of Sports Biomechanics Analysis Based on Intelligent Technology

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Abstract. Sports biomechanics analysis not only plays an important role in the practice of human body movement and a powerful tool for athletes and coaches, but also has a wide range of applications in the field of national defense, medicine, aerospace, industry and so on. This paper introduces the technology of sports biomechanics system based on computer-aided analysis and to the knee. The measurement of the rotational stability of the knee joint was simulated using finite element method. The results of the direct athletes training intensity, angle and intensity have a certain reference value.

Keywords: Sports biomechanics · Sports intelligence · Interactive intelligence

1 Introduction

Sports Biomechanics is an interdisciplinary subject, which has the possibilities of applications in other disciplines. It is widely used in national defense, medicine, aerospace, industry and other fields. Such as the spacecraft has relation with the biomechanics, the astronauts have been successful in achieving the processing of important data to ensure the manning of spacecraft to complete the task.

Wang, established a computational mechanics model of sports bio-mechanics (see Fig. 1), where the force and torque are the input parameters of the model, and it calculated the kinematics parameters of the bio kinetic parameters [1]. Chen while processing the CT images and CAD technology, established a three-dimensional model of the knee joint and the kinetic parameters of patellofemoral [2]. Based on the working principle of the artificial motion simulator designed by Ma, the model of the key parts of the human body movement established by the finite element method, and the kinematic parameters of the joint is calculated during the gait cycle [3]. Wang, pointed out that the analysis of the rigid body not only greatly reduces the computation time, but also can simulate the movement and the force condition very well. With the development of the finite element technique, the stresses of each joint of the human body are analyzed in order to more accurately [4]. Lu by setting up the five kinds of human joint finite element model of different shapes (see Fig. 2), the contact mechanics characteristics of the human body have been studied. The influence of the contact stress and the contact area of the joints is studied in [5].

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Fig. 1. Human movement sensor layout

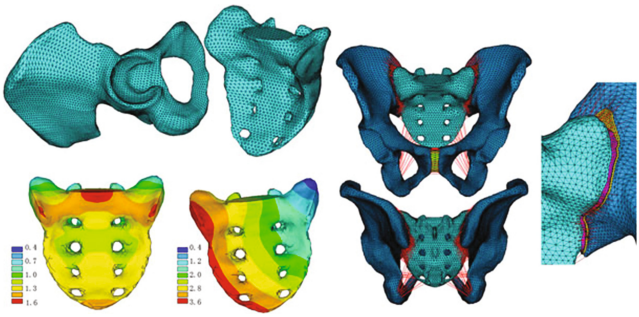

Fig. 2. The body part stress finite element model

This paper introduces the technology of sports biomechanics system based on computer-aided analysis and to the knee. It also measured the rotational stability of the knee joint which was simulated using finite element method.

2 Current Scenario

2.1 Kinematics Research Method

At present, kinematics, dynamics, EMG and other test methods, and means are used to study the mechanical properties of human motion.

Because of the complexity of human motion, it is quite difficult to test the mechanical parameters of human motion. Therefore, in order to ensure the accuracy and reliability of the test, the test methods need to be strictly observed in the process and requirements [6], in order to improve the test accuracy and reduce the error of the new exploration and research (see Fig. 3).

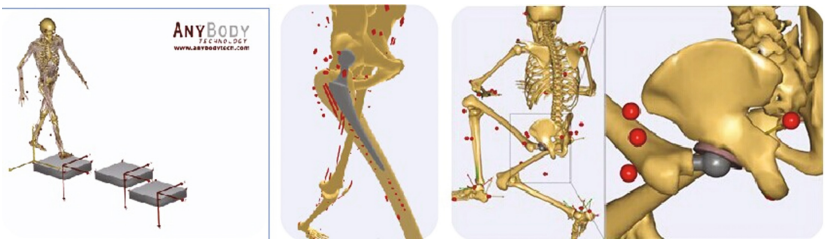

Fig. 3. The finite element model the human body movement

The finite model of the human body movement is now produced. In the process of moving the number of parameters, mainly the camera and image solution analysis of two-dimensional and three-dimensional (3D), the conditions such as an infrared light point transport motion capture and analysis, electric, magnetic induction type transport motion capture and analysis, inertial techniques of motion capture and analysis etc., are arrived. Three dimensional imaging and analytic methods of human motion have been widely used in the technical analysis and research of the athletes as shown in Fig. 4 for athletes to exercise testing.

Fig. 4. Athlete testing

2.2 Sports Biomechanics Analysis System

Sports biomechanical comparison of developed countries begun in the seventies with the research on the sports biomechanics analysis software, and later in the 1980s began the introduction of foreign equipment and software. Sports biomechanics analysis system is becoming more and more popular, domestic colleges and universities, sports

research institutes, sports departments have the corresponding products in use, and the current commonly used services in the sports biology analysis are as shown in Table 1.

Table 1. Text mining in different personalized recommendation services

System name	Major function	Main software	Hardware requirement
Aijie video analysis system	Three dimensional video analysis system	/	Require image memory card
Ariel	Three dimensional video analysis system and gait analysis	APAS	Compatible with three dimensional force table and EMG
Motion analysis	Three dimensional video analysis system and gait analysis	Eva Real-Time	Three dimensional force measuring platform
SIMI reality motion systems	Three dimensional video analysis system and gait analysis	SIMI	Three dimensional force measuring platform
ViconPeak	Three dimensional video analysis system and gait analysis	Vicon MX Peak Motus	Compatible with three dimensional force table and EMG
Qualisys	Three dimensional video analysis system and gait analysis	Qualisys visual 3D	Compatible with three dimensional force table and EMG
Simi-motion	Three dimensional video analysis system and gait analysis	Simi-motion	Compatible with three dimensional force table and EMG
Simi fast image feedback system	Motion image playback	Twinner Pro	/
Mikromak	Automatic analysis system for high speed video recording	WINanalyze	None

3 Methodology

3.1 Human Body Modeling

The aim of building the human body model is to achieve sports biomechanics diagnosis, visualization, and simulation of the first step; the model is established using the model of the human body with the most dynamic features of the multi rigid body system. Both at home and abroad, many experts and scholars proposed many effective simulations of human motion model of the human body. (Such as model Whitsett, model Hanvan, Hatze model, Hong Youlian model and Luo Tejun model). These models are used for a given human motion studies. Each has its own merits and features. Among them, the human body model of Hanvan is a perfect simulation analysis of human movement.

The model of Hanvan body decomposed into 15 parts: viz., pretext, trunk, lower trunk, left upper arm, left arm, left hand and right arm, right arm, right hand, the left

thigh and left leg, left foot, right thigh, right leg, right foot 15 rigid, and the rigid body by hinge form instead of the joint is connected. In the course of movement, according to different forms of movement, the human body model is simplified when the degree of freedom of the human body adjusts.

3.2 Motion Control

After the establishment of the 3D model of the human body, the data of athletes is extracted (extraction method of human motion data used in several ways where one is manual). Second is the computer automatic identification method. Third is the sensor technology. Establishing the differential equations of the human motion for the control of motion, analysis, comparison and diagnosis are proposed with the exercise-training program.

The common methods of establishing differential equations of human motion are the Euler a Newton method, the Lagrange method, the Kane method, etc. The Newton Euler method is simple, concise and processing areas are a vector; a small number of Lagrange equation method, and the income equation is an ordinary differential equation where the processing is a scalar; Kane method using the implicit iterative form, is the simplified equation of manual deduction.

3.3 Interactive Technology

According to the actual needs of the human body model or a simple model of action, it is clear in the image analysis process, and it is required to collect the data, after the analysis of the corresponding kinematic parameters obtained. As a result, the three-dimensional computer display is to reproduce the human body model system in the computer. This is related to the realization of three-dimensional reconstruction technology, which is a three-dimensional computer graphics language.

At present, with the more widespread use of the 3D implementation language OpengL, Direct3D, Java3d and VRML, they can conveniently realize of 3D model construction, to produce a variety of 3D graphics, and to facilitate the realization of a variety of three-dimensional graphics interactive operations.

In the modeling of data processing, to allow users to set or system automatically set the observation point, to allow users to modify the data, and the real-time or sub real time to get the results is modified.

4 Results and Discussion

The finite element method is used to simulate the rotational stability of the knee joint. According to the numerical value of the moment, the rotation torque applied to the model, the joint rotation angle is obtained. The experimental results are shown in Figs. 5 and 6.

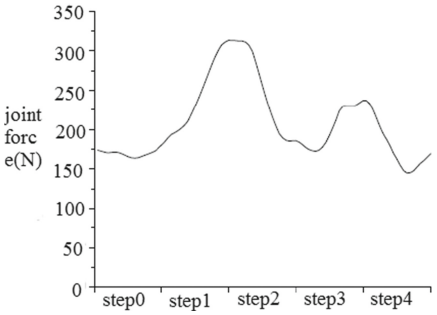

Fig. 5. Curve of joint force change in vivo

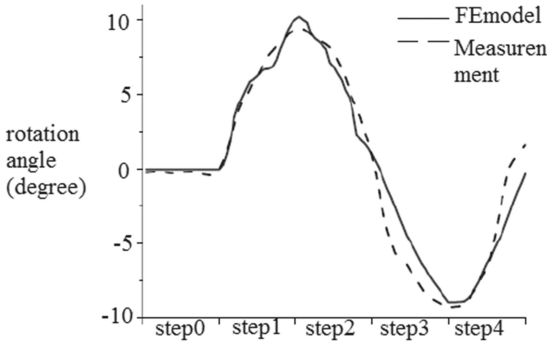

Fig. 6. Finite element analysis and experimental measurement of the rotation angle of the knee joint

Such as curve of the change of the rotation angle of Figs. 2 and 3 shown was obtained from experimental measurement and finite element simulation of the tibia relative to the femur, with the transverse coordinates for the analysis step, vertical coordinate axis rotation angle, in which the solid line represents the results of finite element calculation, and the dotted line represents the results of experimental measurements. From the figure that the results of the finite element model are in good agreement with the experimental results, especially when the second step applied to the inner side of the rotating torque; the two curves almost coincide. The peak internal rotation angle calculated by the finite element model is 10.7°, which is 0.6° larger than the experimental results, and the error between the two is 4.3%. When the rotation torque is applied to the outside, the curvature of the two curves is slightly different, which is related to the loading speed of the moment. The peak external rotation angle of the finite element model is 9.1°, the result is less than 0.28°, and the error between the two is 3.5%. Therefore, the finite element model of the knee joint used to simulate the rotation stability of the passive model, and the error of the calculation results is less than 5%. Therefore, using this model to analyze the biomechanical properties of the knee joint has high accuracy.

5 Conclusions

This paper introduces the biomechanical analysis of different types of human body where many methodological improvements using computer aided design and techniques are applied. This research is particularly more valuable to study the biomechanical properties of the knee joint. We believe that the results of the studies and the methods employed can be applied in a more broad setting to understand the whole body with understanding of the body movements. Due to the conditions of the restrictions, the paper still has much room for improvement, as the current exercise used only the brief coverage of certain elements and the variety of the factors in the future need to be investigated.

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Damping Loss Prevention on Aerobics Special Shoe Materials Based on Intelligent Analysis

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Abstract. In recent years, with the people's awareness of the changes in the fitness movement, aerobics has become one of the most popular sports. Although it is only a moderate intensity of sports items, but there are still likely to be injured in aerobics, therefore, the study of different materials for the special purpose of the shock absorption properties of aerobics has a very important significance. Selected rubber, EVA, TPU these three different materials made of Aerobics special shoes for shock absorption loss prevention test, the structural design of three kinds of shoes. Through the analysis of parameters in the process of the experiment can be seen, TPU materials, damping loss prevention effect are the most ideal rubber anti vibration effect of the worst.

Keywords: Aerobics · Special shoes · Damping material damage

1 Introduction

Shoes are very important to human beings, not only to protect their feet from the damage of hard objects, but also to play a full role in keeping warm. With the changing of social science and technology and the development of human social behavior, people demand on shoes also in the event of a major change has gradually become a kind of personality is the fashion show, it is people's health movement an important tool. Further shoes design, need to consider to meet more function, both to comfortable and beautiful, but also to meet the different temperament demand, for the special needs of shoes, more consideration is light and damping [1]. In previous studies, it is often more important to study the structure design, research on the seismic performance, flexibility, comfort, friction and so on. With the progress of science and technology, all kinds of new materials used in production, the common sports shoes material with rubber, TPU, EVA. These materials have advantages and disadvantages, in price, friction, light resistance, shock absorption and other aspects were different. And in all kinds of sports. In recent years, new aerobics, sports shoes are less, so the aerobics special shoe material shock loss prevention research has a very important significance (see Fig. 1).

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Fig. 1. Aerobics sports show (image from the Xi'an Physical Education University)

2 Present Status

2.1 Aerobic Exercise

Aerobics originated from traditional aerobic exercise, is in music accompaniment, through exercise to the body reach on the effects of physical exercise, in order to obtain a healthy body and aesthetic form, in the process of exercise, achieve the purpose of entertainment and fitness [2]. The characteristic of aerobics is the low and medium intensity of the whole body movement, which is mainly to exercise the heart and lung function of the human body. In recent years, with the deepening of understanding of the fitness movement (see Fig. 2), people pay more attention to scientific and healthy fitness, and also more and more popular for aerobics [3]. Long term aerobic exercise, not only can improve the health of the human body, but also can effectively control the body weight, improve the body, improve the overall coordination of the body. Nowadays,

Fig. 2. Aerobic exercise (image from the Xi'an Physical Education University)

aerobics has developed into a simple exercise, and in the promotion of the development of the national movement.

2.2 Special Shoes for Body-Building Exercise

Although the development of aerobics, sports history is short, but now the majority of the people's love, the body language arts and sports did not study integration, so that it has become a highly ornamental sport activity. Even if it is a low intensity exercise, in the process of movement is still widespread in the case of foot injury [4]. In foreign countries, it has already established a perfect aerobics training system, which can effectively prevent the damage of Aerobics Athletes in the course of the movement. In the study abroad that to prevent in the aerobics movement can effectively reduce the impact movement to the feet of the impact, on the one hand, need to strengthen the training on the ankle and other parts, on the other hand to choose a certain damping loss prevention effect of a dedicated sports shoes [5]. In international competition, the International Gymnastics Federation economy aerobics scoring rules stipulates the athletes must be an appropriate damping function of Aerobics shoes. But no use ballet shoes, running shoes and other sports special shoes. Nowadays, the structural design of the special shoes is not quite different, which has great difference to the material selection. Now the most common way is to choose a high elastic foam material in the shoe, so as to play a better cushioning effect [6–8], the upper with a pure leather upper layer, the sole use of specially designed rubber. This combination of design, can give full play to the performance of different materials, integrated to achieve the effect of non slip, shock absorption, etc.

3 Methodology

The main for three different materials aerobics special shoes for a seismic performance test, three kinds of materials are TPU, EVA and rubber, in order to ensure the test results can be controlled, the shoes structure, size consistent and in one and the same instrument tested, shoes for the new shoes. So in the test of shock absorber, can effectively eliminate the effects of human factors, in the structure consistent to avoid the effect of structure on the seismic performance and the results of the test can reflect the influence of different materials on the seismic performance [9–12]. Test with the shoes in accordance with the "competitive aerobics competition rules" in the provisions of the aerobics shoes to make, the thickness of 0.1 cm, the entire shoe as a whole, there is no distinction between the specific structure [13, 14]. Test equipment for shock testing machine, the seismic performance of the test, the falling weight specific 8.5 kg and 11.9 kg both. The specific parameters see Table 1.

Through the test of different materials, the reference is British SATRA standard Zhongce test method, through 8.5 kg and 11.9 kg these two different weight levels drop from the different heights of the fall, to achieve different output energy 5 J, 7 J on three kinds of sole material impact, after obtaining ram movement acceleration and the impact process of different parameters recorded and calculated to three materials aerobics special shoe cushioning performance evaluation. The ram diameter is 4.5 cm, head of

radius 3.75 cm. The parameters that need to be recorded mainly have the *G* value that is the maximum impact force peak, and then carry on the contrast between various materials.

Table 1. Text mining in different personalized recommendation services

Entry name	Content
Drop weight	8.5 kg (5 J), 11.9 kg (7 J)
Impact head specification	R = 1.0 ± 0.25 mm, D = 45 mm, m ≤ 0.2 kg
Drop height	Height of each test 50 mm
Impact energy requirement	5 J, 7 J
Test speed	2 + 1 s per cycle
Load cell capacity	5000Ibf, sampling frequency >1000 Hz
Displacement transducer	0~100 mm, sampling frequency >1000 Hz
Power Supply	AC220 V, 50 Hz

First, by the test instrument of the ram shoes impact, the impact energy increased gradually from low to high, every time the impact energy of the record three times the effective collision data, each two impact test between time intervals respectively 1 min, after completion of 2 times the energy impact tests, replace the shoes under a set of tests. Finally, the parameters of the impact process were recorded, including displacement, force and impact energy, etc. With the increase of impact force, the deformation displacement of the material becomes larger. When the impact energy reaches the preset maximum impact energy 5 J and 7 J, the force value and the energy decrease gradually, and the material begins to recover slowly.

In accordance with the established test methods and, ultimately, the impact test process parameters, and according to the parameters of the different impact energy of the impact force peak value and the value of *G*, where *g* values for the impact generated by the maximum acceleration and the weight of the acceleration ratio. If the material has a good damping performance, then the production of shoes can effectively reduce the impact force peak value and *G* value. When the peak value of the impact force and the *G* value is less, the seismic performance of the tested material is better.

4 Data, Analysis and Discussion

With the impact energy and shoes as independent variables, to the maximum impact force peak and g value as variables, you can draw the shoes of different materials under different impact energy of impact force peak, details see Table 2.

Through the absorption of shock performance test results can be seen: (1) the impact energy is 7 J, 5 J impact energy with respect to *a*, the maximum impact force peak and *g* values, indicating that the under relatively high impact energy, the shoes produced by the maximum impact force peak and *g* value is larger; (2) under the same impact energy can be seen, the seismic performance from low to high were rubber, EVA, TPU (see Fig. 3).

Table 2. Table of the maximum peak value and G value of different impact energy

Material classification	Impact energy (N)			
	G value comparison		Peak comparison	
	5 J	7 J	5 J	7 J
Rubber	28	37	2174.54	2876.46
EVA	24	33	2135.25	2756.91
TPU	20	30	1870.52	2634.52

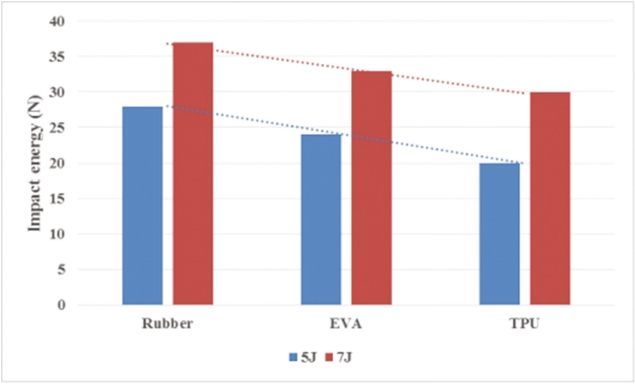

Fig. 3. Comparison of G value under different impact energy

Thus we can see that, TPU materials collision impact force peak and g value minimum. It indicates that the the seismic performance of the best (see Fig. 4), to have a more intuitive observation of the relationship among the different materials of the maximum impact force peak value and the value of *G*, of three different materials between attenuation coefficient are analyzed (Table 3).

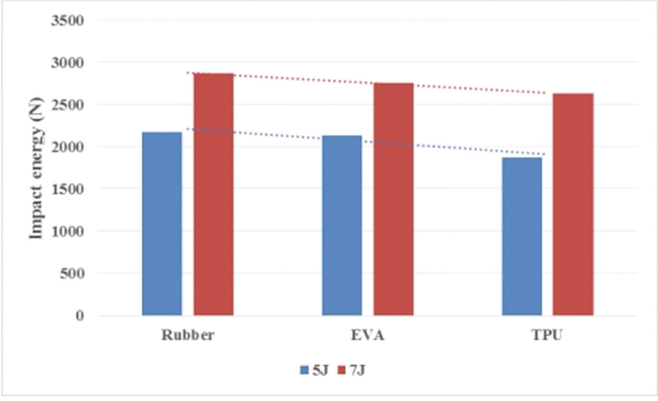

Fig. 4. Peak contrast of different impact energy

Table 3. Decay rate of different materials under different impact energy

Maximum impact force	5 J		7 J	
	TPU with respect to rubber	EVA with respect to rubber	TPU with respect to rubber	EVA with respect to rubber
Peak comparison	−14.0%	−1.8%	−8.4%	−4.2%
G value comparison	−28.6%	−14.3%	−18.9%	−10.8%

See from the TPU and EVA materials in 5 J and 7 J hit the maximum impact force peak and G energy values of the attenuation coefficient can be at the maximum impact force peak contrast, TPU relative to the rubber in the impact energy under 7 J 5 J, 14%, 8.4% respectively attenuation, EVA relative to 5 J, 7 J rubber in the impact energy. The attenuation of the 1.8%, 4.2%; the *G* value comparison, TPU relative to the rubber in the impact energy under 7 J 5 J, 28.6%, 18.9%, respectively decrease, compared with EVA in 5 J, 7 J rubber impact energy under 14.3% attenuation and 10.8%. can be seen with respect to the rubber material, the decay rate of TPU and EVA decreased significantly that is, the seismic effect is obvious, but the percentage of two decreases, TPU attenuation is more obvious, also shows that the damping effect of TPU material is good.

Is the maximum impact force peak, EVA in the impact energy 5 J, 7 J phase compared with rubber, although there are decaying, but the attenuation is not obvious, explained the EVA in the seismic effect although the rubber, but the performance difference between the two. And the rubber itself is more emphasis on the friction, the seismic performance is relatively poor. Although the EVA material has a good portability and flexibility, but the seismic effect of TPU compared with the lack of a large.

5 Conclusions

In this paper, we mainly study the rubber, EVA, TPU these three kinds of different materials in the aerobics special shoes damping loss prevention performance of, mainly through to three kinds of different materials, but structural design consistent fitness for seismic performance test of special shoes, respectively in 5 J and 7 J impact energy under different *G* value and the peak impact force. It can be seen from the test that the seismic performance of the three materials from high to low are TPU, EVA and rubber. Therefore, in the specific design and manufacture process of Aerobics special shoes, the choice of materials should be given priority to TPU. But because aerobics special shoes not only consider the seismic effect, also need to consider anti slide, and comfortable degree of cost. Therefore, it is necessary to carry on a comprehensive consideration of, choose all aspects of performance are better able to meet.

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Real-Time Alert Systems

Application of Neural Network Algorithm Based on PCA-BP in Earthquake Early Warning of Buildings

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Abstract. This paper established an efficient and practical earthquake damage prediction method for buildings by combining principal component analysis (PCA) with neural network. To avoid BP neural network from being caught in a local minimum, according to the features of PCA algorithm, this paper combined the two to form PCA-BP mixed model and trained the network through the initial weight of PCA-optimized neural network. Based on a collection of large quantities of earthquake damage data of buildings, this model was introduced in earthquake early warning for buildings. The results show that this method can predict earthquake for buildings in an effective and accurate way.

Keywords: Principal component analysis · Neural network · Earthquake early warning

1 Introduction

An Earthquake early warning is an important topic in the geographical problem research field. There are many factors which result in an earthquake. The reason complexity, nonlinearity of generative process and difficulty in cognizing the problem make people difficult to establish sound a physical theoretical model [1]. The accurate description of relevant physical parameters can be only analyzed, summarized and reasoned through some superficial phenomena observed [2]. Relative to traditional prediction method, the neural network has unique advantages in handling such problem. Its advantages, mainly include strong fault-tolerant capability. Fast prediction or recognition speed, and avoidance of complex relationship description of characteristic factor and discriminating object and especially the formula expression. The network can learn and remember the relationship between each input and output [3]. However, due to the local minimum problem, the slow convergence rate of the algorithm and the difficulty in determining the number of neurons in the hidden layer, we introduced PCA algorithm with optimization function in earthquake prediction for buildings.

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2 Fundamentals of PCA-BP Neural Network Algorithm

2.1 Fundamentals of PCA

PCA is a statistical analysis technique which can simplify multiple indicators with certain relevance used to describe sample features to a few comprehensive indicators [4]. Since each variable reflects some information of problems studied to different degrees, and the indicators have certain correlation, the results reflected in statistical data repeat to some extent. Thus, PCA takes advantage of the thought of dimensionality reduction, and can optimally summarize and simplify original variable system on the basis of guaranteeing original data. Meanwhile, PCA can objectively confirm the weight of each indicator parameter and avoid randomness caused by subjective judgment. Based on original data, PCA is used to find out comprehensive indicators which are combined with several indicators through linear transformation. These principal components can reflect features and information on original indicators, and they are mutually independent [5].

2.2 Fundamentals of BP Neural Network

Rumelhart et al. [6] proposed error back propagation learning algorithm of BP network in 1986. Its fundamental is to estimate the error of direct forward leading layer in the output layer by applying the error after output. Then, this error is used to estimate and correct the error in the previous layer. Similarly, back propagation is conducted layer by layer. In this way, error estimation of other layers can be gained. Such algorithm is called a BP neural network algorithm. As a reverse propagation correction of errors is conducted continuously, the accuracy of network for input mode will also rise continuously.

From the characteristics and functions of neuron, we can know that neuron is an information processing unit of multi-input and single output. Its information processing mode is nonlinear. According to the characteristics and functions of neuron, neuron can be abstracted to a simple mathematical model. Artificial neuron model in engineering is expressed as X1, X2, …, Xn which are the input of neuron, i.e., the information from *n* neuron axons at the previous level. θ is threshold value of neuron. Wi1, Wi2…, Win are weight coefficients of X1, X2, …, Xn, respectively, i.e., the transmission efficiency of axons. Yi is the output of i neuron. f[•] is excitation function which decides the output mode of X1, X2, …, Xn when their common excitation reaches the threshold value. Neural network based on the BP algorithm makes the network's own nonlinear mapping ability through the composite action of multiple neurons with simple processing function. Such network has no feedback and belongs to feed-forward network [7]. Theoretical completeness and extensive practicability decide its position in artificial neural network.

2.3 Computer Neuron Model

Figure 1 shows a neuron model with n inputs.

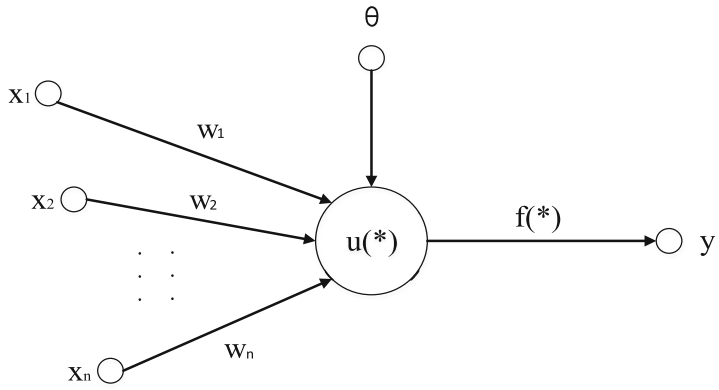

Fig. 1. Neuron model

2.4 Advantages of BP Neural Network in Earthquake Prediction Evaluation

Based on the above analysis, we can see the BP neural network has its unique network structure and innovation principle. It has the following advantages, relative to other common linear regression model and traditional statistical method:

(1) Nonlinear mapping capacity: when sufficient typical data samples are provided for training, BP neural network, which contains only one hidden layer can achieve any complex nonlinear mapping from n-dimensional input space to m-dimensional output space with any precision, and the effect is optimal under the condition of the one-dimensional output. In this process, it is unnecessary to fully understand the inherent complex mechanism of things or phenomena, and the required mapping relation can be gained only through data. Thus, it contributes to achieving grasp of complex systems in the form of "black box".

(2) Self-learning and generalization ability: through a lot of training, BP neural network can learn unknown or uncertain system according to sample input and output data, extract internal mechanism or rules from the data to store them, and generalize them to other untrained sample data in the system so as to achieve a correct mapping from input to output. This is the generalization ability. It is very important to train the neural network with better generalization ability. In this way, input prediction can be achieved with sufficient precision under the condition of gaining input data.

(3) Parallel distributed processing mode: data, information inputted in a BP neural network gets to each layer of a neuron in a parallel and simultaneous way, and all data information is equally distributed and stored in each neuron. Such parallel distributed processing mode not just makes neural network own fast training

speed and makes fast and plentiful complex operations possible, but also makes it have the very strong robustness and fault tolerance. Thus, even if the input sample has large error and even there is individual mistake, the influence on general inherent rule of sample extraction by the network is very small.

3 Sample Collection and Analysis

3.1 Indicator Selection

Earthquake refers to the vibration caused by earth's crust in the process of releasing energy. Nowadays, scientific community widely believes that there are at least 10 indicators which reflect the features of earthquake precursor. At present, there is the professional instrument used to record the data of these indicators per second at multiple fixed points, in the hope of finding out features of earthquake precursor through analyzing and studying the data.

The data of more than 10 indicators which were observed per hour from January 1, 2010 to June 30, 2015 have been collected. Besides, such data as earthquake time, longitude, latitude, earthquake magnitude and depth of focus have been gathered. Data characteristics of earthquake precursor are hidden in these data. Hence, this paper aims to study these data characteristics.

Indicator collection results include 11 indicators: electromagnetic wave radiation EW, voltage, hydraulic pressure, water temperature, water level, electromagnetic wave range NS, rainfall, air temperature, ground temperature, clinometer NS and clinometer EW.

3.2 Comprehensive Indicator Model Based on PCA

It is found from analysis of the above 11 indicators that these indicators reflect relevant features of seismic activity. Among these indicators, they may have a certain correlation between every two indicators [5]. To solve the influence of different opinions caused by abnormal changes of indicator data, PCA was applied to simplify multiple indicator parameters and construct comprehensive indicators for earthquake prediction research.

Through PCA, the coefficient (feature vector), eigenvalue and contribution rate of 11 indicator parameters in each principal component were gained (See Table 1).

According to the data in the table, the accumulative contribution rate reaches 87.32% when 6 principal components are taken; the accumulative contribution rate reaches 88.4% when 7 principal components are taken. Thus, most information has been included in the samples when the first 6 principal components are taken.

The first 6 principal components were taken to calculate comprehensive indicator W of earthquake intensity. 5 earthquakes were chosen for further analysis. The changes of each earthquake with time were gained. The comprehensive indicator W can well

Table 1. Coefficient (feature vector), eigenvalue and contribution rate of each indicator in principal component

	Principal component					
	1	2	3	4	5	6
Voltage	−0.01703	−0.27508	0.055663	0.63016	0.155233	−0.384523
Electromagnetic wave radiation EW	0.360851	−0.44905	−0.28043	−0.02084	0.044826	0.108391
Electromagnetic wave range NS	0.364234	−0.43564	−0.27453	−0.00459	0.047234	0.101637
Ground temperature	0.243729	0.294381	−0.0604	0.181793	0.246045	0.36811
Water level	0.356447	0.376523	−0.09965	0.224282	0.033099	−0.07456
Air temperature	0.158494	−0.07199	0.68592	−0.0846	−0.07448	−0.08254
Air pressure	−0.32386	0.379344	−0.37262	0.17452	0.083682	0.052405
Water temperature	0.31945	0.186354	0.186387	0.440202	0.043832	−0.033334
Rainfall	−0.10236	0.11864	−0.323244	0.083422	0.0534834	0.343456
Clinometer NS	−0.42272	−0.19692	0.190857	−0.36578	0.868818	−0.32486
Clinometer EW	0.366227	0.2484458	0.214058	−0.27738	−0.1158	0.051783
Eigenvalue	2.932	2.2019	1.7401	1.201	0.9785	0.8853
Contribution rate	24.43%	18.35%	14.50%	10.01%	8.15%	7.38%
Accumulative contribution rate	24.43%	42.87%	52.79%	67.29%	75.45%	82.83%

	Principal component				
	7	8	9	10	11
Voltage	0.158494	0.186387	−0.00459	−0.00459	0.68592
Electromagnetic wave radiation EW	0.379344	−0.37262	0.083682	0.11864	−0.32386
Electromagnetic wave range NS	−0.36578	0.31945	0.043832	0.440202	0.186387
Ground temperature	−0.37262	0.0534834	0.181793	0.181793	−0.0846
Water level	0.186387	0.033099	0.0534834	0.0534834	0.17452
Air temperature	−0.323244	−0.07448	−0.0846	−0.0846	−0.07448
Air pressure	0.190857	0.083682	0.17452	0.17452	−0.00359
Water temperature	0.214058	0.043832	0.440202	0.440202	0.12864
Rainfall	1.7401	0.0534834	0.083422	0.083422	0.44342
Clinometer NS	−0.37262	0.033099	−0.36578	−0.36578	−0.00459
Clinometer EW	0.052334	0.17452	−0.34535	−0.23434	−0.045324
Eigenvalue	0.6661	0.5702	0.4114	0.2908	0.097
Contribution rate	5.5%	4.75%	3.43%	2.45%	0.87%
Accumulative contribution rate	88.38%	93.13%	96.34%	98.45%	99.34%

reflect comprehensive features of seismic activity abnormality. Through comparing the weight of each factor, we can know that the value of W is basically determined by water levels, electromagnetic wave radiation EW, electromagnetic wave range NS, clinometer EW and clinometer NS.

3.3 BP Neural Network Model Building for Quantitative Characteristics of Before the Occurrence of Earthquake

The BP neural network was applied to establish the nonlinear relationship between input and output, and to analyze quantitative characteristics before the occurrence of earthquakes. 6 comprehensive indicators served as the input layer of the BP neural network, and magnitude information of the biggest earthquake which happened within the subsequent one month served as the target output. Historical data in 2010–2013 were chosen to extract the information of 6 samples, as shown in Table 2.

Table 2. Earthquake measurement indicators (before normalization processing)

Sample No.	X_1	X_2	X_3	X_4	X_5	X_6	The biggest earthquake magnitude in the next month
1	26.87	3.90	4.89	17.75	−0.38	0.03	2.3
2	26.72	−2.15	4.5	17.57	1.06	0.11	3.6
3	26.88	−3.52	2.81	17.57	−2.00	0.01	3.1
4	26.96	−3.30	3.05	17.57	−1.99	0.04	3.1
5	25.66	−0.69	5.13	17.61	−2.00	0.43	3.2
6	26.73	0.51	6.51	17.62	−2.00	0.25	3.0

One dimension of BP neural network input represents a feature. The input of neural network is multi-dimensional. The mode to be identified has multiple features. If the data are directly used for network operation without processing, data singularity will occur. Singular samples will result in training failure. Thus, normalization processing should be conducted before the BP network model is constructed.

In this paper, each input was normalized to the interval of [0.1, 0.9]. At the input layer, Formula 1 was used for normalization processing:

$$P = 0.1 + \frac{0.8 \times (q - q_{\min})}{q_{\max} - q_{\min}}, \quad \text{p is network input.}$$

Normalization processing of input layer could well solve the data singularity problem. Finally, counter-normalization processing of data at the output layer should be done. At the output layer, the following formula was adopted:

$$\mathrm{q} = q_{\min} + \frac{(y - 0.1) \times (q_{\max} - q_{\min})}{0.8}, \quad \text{y is network output.}$$

The results of normalization processing are shown in Table 3.

Three-layer feed-forward BP network was established. The above 6 neurons served as the input nodes, and the output layer adopted the biggest earthquake magnitude as the output node. Through comparison and training many times, the number of neurons

Table 3. Earthquake measurement indicators (after normalization processing)

Sample No.	X_1	X_2	X_3	X_4	X_5	X_6	The biggest earthquake magnitude in the next month
1	0.85	0.90	0.55	0.90	0.10	0.52	0.1
2	0.75	0.25	0.39	0.11	0.20	0.90	0.9
3	0.85	0.10	0.10	0.10	0.61	0.10	0.592
4	0.90	0.12	0.15	0.10	0.63	0.10	0.593
5	0.19	0.41	0.60	0.10	0.90	0.10	0.531
6	0.76	0.54	0.90	0.30	0.85	0.10	0.654

in the hidden layer was finally confirmed, i.e., 8. The normalized data were utilized to train BP neural network. The trained network might meet actual application demand.

After 2134 times of training, the fitting effect was very good, and the target error of network reached the requirement. The predicted earthquake magnitude was gained after counter-normalization processing of output results. The MSE prediction error of the network could be obtained through comparing predicted earthquake magnitude with actual earthquake magnitude. We can see from Table 4 that, the difference between the biggest earthquake magnitude gained by BP neural network and actual earthquake magnitude is 0.08; neural network can correctly recognize 6 learning samples, and the prediction error is small; the inner inspection result is very high. Thus, the properties of the model can basically meet actual application requirements.

Table 4. MSE error analysis sheet of BP neural network prediction model

Sample No.	Actual earthquake magnitude	Predicted earthquake magnitude	Earthquake magnitude difference ΔM	Prediction error
1	2.3	2.344	−0.044	0.019079
2	3.6	3.578	0.022	0.006001
3	3.1	3.173	−0.073	0.023537
4	3.1	3.108	0.082	0.026488
5	3.2	3.232	−0.032	0.010079
6	3.0	2.982	0.018	0.006143

4 Conclusion

This paper studied the application of PCA-BP model in building earthquake prediction. The sample analysis results indicate that it is feasible and accurate to predict building earthquake with PCA-BP neural network. The prediction error is small and can basically meet actual application requirement. Therefore, PCA-BP neural network has certain prediction application research value. Due to the restriction of sample data, generalized analysis is not carried out. Thus, it is the follow-up research emphasis.

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Algorithm Design on Filtering Signals in Cable Defect Magnetic Flux Leakage Non-destructive Testing System

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Abstract. Cable defect magnetic flux leakage non-destructive testing system is designed according to the characteristics of cable-stayed bridge cable nondestructive testing. The measured results show that the defects of the magnetic flux leakage signals are often accompanied by a lot of noise signals, which leads to signal characteristics no significant. In filtering signal algorithm, first to do the smoothing and filtering processes, then to obtain the signal by characteristic differential of limitation after quantization process characteristic, at least to acquire the object internal defects by the BP neural network. Simulation results show that after dealing with the filtering algorithm of magnetic flux leakage signal characteristics significantly, which provides a reliable basis for the nondestructive testing and analysis of the bridge cable wire brake defect.

Keywords: Magnetic flux leakage non-destructive testing · Smoothing · Filtering algorithm · Neural networks · Signal algorithm · Smoothing processing

1 Introduction

Cable-stayed bridge cable in the open state for a long time, the polyethylene (PE) sheath sclerosis and cracking, will cause the sheathed wire bundle of corrosion [1], the vibration of the bridge and the cable's internal force also can accelerate cable wear and ageing, thus produces local defects such as broken wire cable. Broken wires defect is the first factor of affect cable-stayed bridge safety and service life, which is likely to cause the overall structure of catastrophic destruction [2]. The commonly used cable nondestructive testing methods, including ultrasound, magnetic bridge circuit and leakage magnetic field test, etc. Among them, the Leakage Magnetic Field detection method has high detection sensitivity to the internal defects of ferromagnetic material, and it also has the advantage of surface cleanliness of the test object not high and low cost, which are widely used in nondestructive testing of internal defects such as broken wire cables of cable-stayed bridge. But due to space Magnetic Field, PE protective layer and the site environment, the influence of such factors as defect Magnetic flux Leakage signals are often accompanied by a lot of noise signal, cause no significant signal characteristics [3]. To this, the signal cable defect detection system filtering algorithm is applied in this article, the signal-noise separation, magnetic flux leakage signals to obtain significant defect

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information [4, 5]. Test results show that after dealing with the filtering algorithm of magnetic flux leakage signal characteristics, it can be used in cable-stayed bridge cable wire brake defect of nondestructive testing.

2 Cable Defect Magnetic Flux Leakage Non-destructive Testing System

Cable type defect magnetic flux leakage non-destructive testing system using a HMC1022 magnetic resistance sensor to magnetoelectricity conversion [6, 7], and converts electrical signals of die in and die B into a numerical value through the AD converter. The test information sends into the single chip microcomputer after simple judgment, effectiveness by single chip microcomputer, through wireless communication module and a wireless network, sending to the monitoring computer, processing and displaying information from monitoring computer. The cable defect magnetic flux leakage detection system block diagram is shown as Fig. 1.

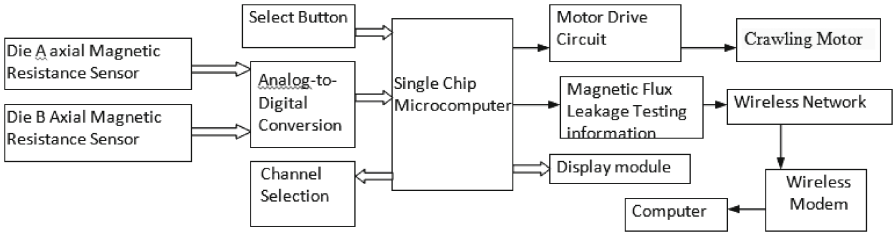

Fig. 1. The cable defect magnetic flux leak age non-destructive testing system diagram

3 Algorithm Design on Filtering Signals

After the simple processing of single chip microcomputer to the non-destructive testing signal, the magnetic flux leakage testing data is sent over a wireless network to the monitoring computer. Experiments find that the testing data existing pulse interference and noise more volatile, etc. Filtering signals uses wavelet analysis and BP neural network method, to do the filtering processing and signal-noise separation for the collecting data, in order to get significant gaps information. In the algorithm, first do the smoothing and filtering processing to the signals; After obtaining smooth signals, do the characteristic quantitative processing to results in order to get the difference of limitation in the signal characteristic; At last, take the finishing data as the BP neural network input, incoming to the BP neural network in pattern recognition, obtaining obvious defects. Algorithm processing steps are as following steps.

Step 1: Input the original data;
Step 2: Smoothing processing;
Step 3: Micro-smoothing processing;
Step 4: Enter the smooth data after processing;

Step 5: Wavelet packet filtering processing;
Step 6: Input the non-noise signals after processing;
Step 7: Calculate the value of differential limitation
Step 8: Sorting data, input to the neural network
Step 9: BP neural network pattern recognition
Step 10: Output defect information

3.1 Smoothing and Micro-smoothing Algorithm Design

From detection signal you can see, the original signal interference, the obvious phenomenon of spikes (pulse), especially in strengthening the signal of the magnetic field, spikes phenomenon is more obvious. Spikes are different from defect signals, and its obvious characteristic is increased in a short period of time and will be harmful to signal identification. Therefore, to deal effectively with the signal data, we must eliminate the signal of spikes, namely to processing smooth signal. Smoothing algorithm design step is shown as following steps.

Step 1: Initialization;
Step 2: Strives for the abnormal signal of the maximum and the minimum value of abnormal signal;
Step 3: If the original signal in the first place I happen to be the first m a great value, with great value as the center, wide width as the wave, to smooth the signal; If the original signal in the central plains signal the position I happens to be the first n minimum, with minimum as the center, wide width as the wave, to smooth the signal;
Step 4: Output data after smoothing

By specifying the spikes signal and wave form width of upper and lower limits, the elimination of the spikes signal can be realized. In addition, after the initial smoothing, signal still exist a few small spikes. While the tiny spikes within the scope of the normal signal, but is still likely to affect the subsequent processing, so you need to processing micro-smoothing signal.

3.2 The Algorithm Design on the Differential Limitation

The signals have no phenomenon of spikes after smoothing, but the signals still exist a small fluctuation situation, that is to say the noise interface still exist in the signals, so need to do the signal filtering [8–10]. In numerous filtering tools, wavelet can do the signal decomposition and reconstruction, analyze and filter the signals in different frequency. So the magnetic flux leakage signal frequency can meet the rigid object composition is complicated, need multiple frequencies of signal filtering [11–13].

Difference transfinite number can be used to identify and analyze the signals of local anomalies. Through the analysis can be found, when local abnormal changes in the signal, the signal amplitude between two adjacent sampling points difference of absolute value is greater than normal range generally poor score [14–16]. If a threshold set in

advance, it can be a minor change interval, will change to local isolated anomaly over threshold method of absolute value of the difference in the number of sampling points accumulation, to get the characteristics-differential limitation. And the rule is when the distance between the differential limitations less than a certain value then presents to a same abnormal range. The differential limitation is presented as D0.

$$D_0 = \sum_{m=-\infty}^{+\infty} T[x(m)]W(L-m) \tag{1}$$

In here:

$$T[x(m)] = c[x(m+1) - x(m)], \quad m \in (-\infty, +\infty) \tag{2}$$

C(u) as the threshold function, namely

$$C(u) = \begin{cases} 1, & |u| > t \\ 0, & otherwise \end{cases} \tag{3}$$

t for the set threshold. w(n) as the window function,

$$W(n) = \begin{cases} 1, & -Ni \le n \le 0 \\ 0, & otherwise \end{cases} \tag{4}$$

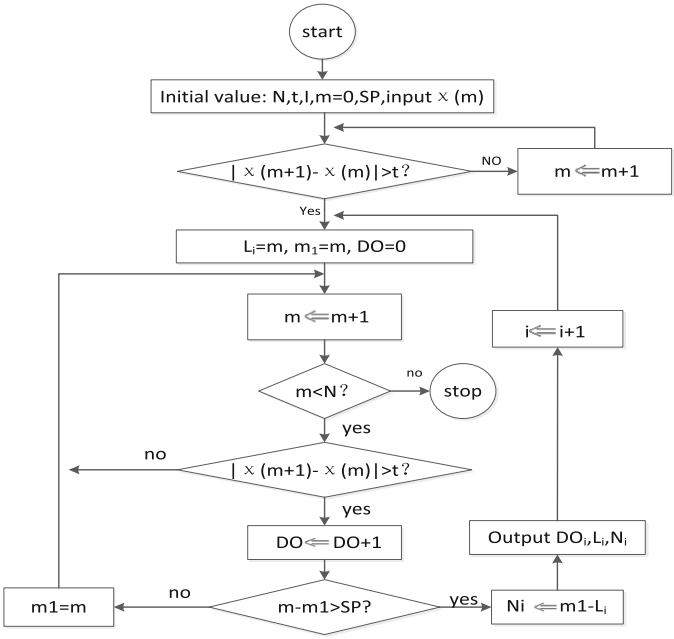

Fig. 2. The differential limitation algorithm

N_i is windows' width, its' size can change as local signal in the area of abnormal. The differential limitation algorithm design is shown in Fig. 2.

In Fig. 2, Li equals to L(i) in the algorithm, D0 equals to DiffNum in the algorithm, Ni equals to widthNoise (i) in the algorithm, SP equals to widLimit in the algorithm.

3.3 Algorithm Design on BP Neural Network Pattern Recognition

The BP neural network is the most used neural network model, which belongs to the former-type network model and is suitable for the analysis of the magnetic flux leakage signal recognition [8]. Through the study, we can find that the cable's main defects are relate to the factors such as broken wire, peek to peek absolute peak value, pulse width, detection speed in the detection signals, so can take it as the input parameters in the BP network.

In order to guarantee the monotone nonlinear relationship between the output and the input parameters, before the input of the BP network, various parameters must be normalized processing, that is to normalize the inputs between in [0, 1], because of the hidden layer function in the, 0.1 [0] and [0.9, 1] between changes slowly, so it can be normalization the inputs between [0.1, 0.9]. If you need the inputs values are still falling within the scope of the [0.1, 0.9] after normalization, you should use the normalization formula.

$$A_{,} = \alpha + \beta(\alpha_i - T_{\min})/(T_{\max} - T_{\min}) \tag{5}$$

In the formula, α is the low limit of the normalization processing range, β is the interval span. The main function of the program is designed as following.

```
//main function
void main()
{
        TRAIN TrainingData[NUM];
        NET Net;
        InitializeRandoms();//Initializes the pseudo random number generator
        GenerateNetwork(&Net); // Build a network
        InitializeApplication(&Net); // Application initialization, ready to run
        RandomWeights(&Net); // Form the initial weights
        InitializeTrainingData(TrainingData); // Record the training data
        TrainNet(&Net,TrainingData); // Start training
        JudgeNet(&Net);
        FinalizeApplication(&Net); // Program closed, complete the work
        return;
}
```

In this algorithm, according to the structure characteristics of BP neural network, we build a three layers BP neural network, including the input layer, hidden layer and output layer, the input layer node number is 4, take 20 each hidden layer neurons, initial weights

of the random number takes between [1, 1]. Adopt the corresponding data structure, using C language implementation in the construction of the BP neural network structure, prior to transmission, back propagation error modification as well as the network training etc. and input the distinguish data to the network to achieve the ideal pattern recognition. In this case, take the momentum coefficient is 0.9, learning coefficient is 0.7, the error is less than 0.0001.

4 The Simulation Results

In this system, for example, a set of experimental data and the original signal, smooth signal, filtering signals and its characteristics of quantitative comparison is shown in Fig. 3.

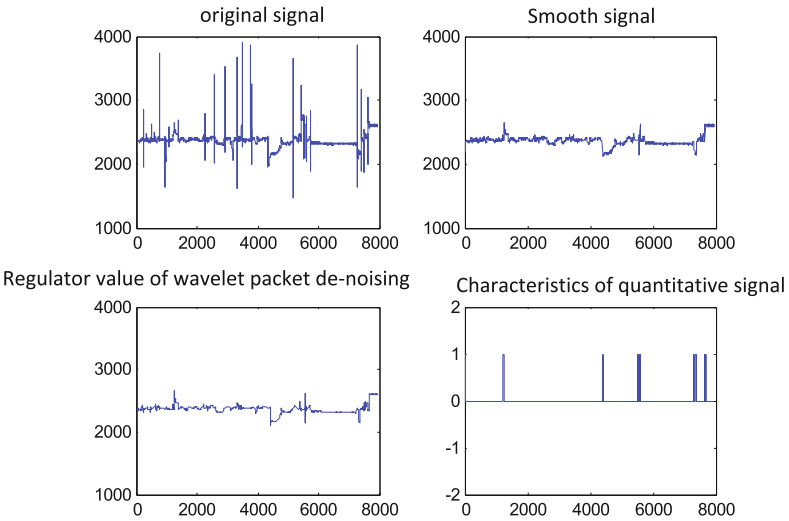

Fig. 3. Signal processing effect contrast diagram

From the Fig. 3, we can see if we don't take the disturbance of jump start and the end wave signal into the consideration, signal smoothing and filtering effect is satisfactory, characteristics of quantitative characteristics of signals can also appear to be more significant. At this point, the signal preprocessing is finish, save the output after finishing, as the BP neural network input to transfer to the BP neural network.

By using BP neural network pattern recognition, the result output is shown in Fig. 4. If we don't take the disturbance of the beginning and the end into consideration, we can see, there are three broken wires defects, recognition effect is satisfactory.

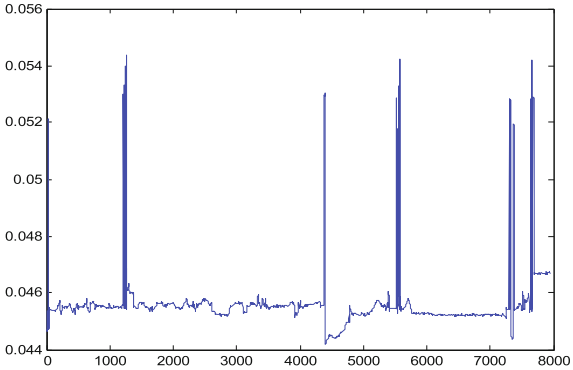

Fig. 4. The results of using bp neural network pattern recognition

5 Conclusion

According to the cable-stayed bridge cable magnetic flux leakage testing signals with the characteristics of no significant amounts of noise and signal characteristics, this paper uses signal analysis methods such as the difference transfinite signal smoothing, wavelet packet filtering and BP neural network pattern recognition etc. to collect information to do the filtering processing. The simulation results show that the filtering algorithm of the cable-stayed bridge cable magnetic flux leakage testing signal has good practicability and filtering precision. But this filter algorithm is under the condition of single cable diameter, in the case of different cable diameter, experimental data will increase new disturbance, so the method remains to be further study in the stability.

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Multi Controller Software Defined Network Link Fault Location Based on Tree Decomposition Method

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Abstract. In order to overcome the problem that the existing scheme is difficult to adapt to the network link additions and deletions to the situation, this paper proposes a link fault localization scheme based on tree decomposition. Firstly, a multi degree lossless image segmentation algorithm is proposed to divide the network into several independent sub networks. Secondly, the maximum width priority tree decomposition algorithm is proposed to generate multi loop in the sub graph. The average number of links and the total delay of the proposed algorithm are better than that of the genetic algorithm. Experiments show that the number of indicators such as static flows in the schema needed to be sent to the table and detection information needed to be sent to detect link faults is superior than the existing programs.

Keywords: SDN · Link fault locator · Decomposition tree · Image segmentation

1 Introduction

Software-defined network is a new network architecture model. It will separate control and forwarding network, through the open software defined API to realize the flexible reconfiguration of the network function [1]. With the use of the SDN in the WAN, the control layer using a single controller cannot complete the statewide network monitoring and management. To achieve scale control layer, a plurality of controllers together to complete the whole network management and monitoring become the development direction of large-scale deployment [2]. Although the multi controller can achieve the management and control of large scale software defined network, it also brings some new problems. For example, in a multi controller software defined network, each controller only manages a portion of the network. Multiple controllers need to exchange the network topology information in their own control domain. In this way, the whole network topology information can be generated by each controller. On the basis of the application of the controller, a variety of resource management and allocation decisions are made. But when a controller and its control domain switches between communication fault, or a controller of its control domain switch control ability is weak, the controller will not be able to correctly, efficiently obtained body control network

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topology information in the domain. Therefore, it is very important to have a full network topology information for a controller.

2 Research Status

In a multiple controller, how to achieve a single controller link failure detection and location in the network and then get the complete information of the entire network topology is a new topic.

Ulas proposed a single controller to use its own master network topology information to generate all links in the single loop overlay network [3]. And in order to send the OpenFlow switch to the static flow table entry (the number of flows close to the number of optimizations), the single loop will be generated in the OpenFlow switch network. The controller can detect the topological state of the network by transmitting the detection information to the single ring, and it is able to detect and locate the link fault in the network by forwarding speed of the data path. At the focus of the study is to ensure the generation of single-ring overlay network on the basis of all the links, so that repeated single ring path contains the minimum number, thereby reducing the number of controllers to switch delivers static flow rules. On this basis, the author analyzes the number of single-loop positioning network link failure.

Khurshid main research is how to monitor the real-time flow rules issued, modification and deletion influence to the whole network status [4]. The authors suggest adding a "VerilFlow" layer between the control and data forwarding layer, which is the first function of an existing network into multiple equal subnets, and access to each subnet data forwarding topology.

Wundasm describes how to locate network problems in a network switch or router configuration problem caused [5]. This paper present OFRewind modules, it can achieve large-scale, centralized control of the network and the continuity of the recording and replay functions based on the SDN network. Through these two functions to identify the control software failure, data forwarding in the link bottleneck and positioning switch or router configuration fault.

Hongqing Zeng and Changcheng Huang heuristic spanning tree algorithm to generate a network topology tree, it not included in the tree and the tree link connection generates a detector ring [6]. Based on the generated ring signal generator to be placed and received signals, signal generator sends a detection signal to the ring to locate the all-optical network link failures.

Ying Xuan mainly to solve how to locate Optical Networks multi-link failure problems, this paper proposes a centralized tree decomposition algorithm and random walk localization algorithm [7]. Centralized decomposition algorithm suitable for small networks, the algorithm generates network topology tree subgraph, and the signal generator is placed on the root node of the tree, and place the signal receiver on the leaf nodes of the tree. The Random walk algorithm is suitable for large networks, the algorithm randomly generated multiple paths in large networks. Until the resulting path contains all the links in the network, the algorithm terminates. Although the two algorithms can

locate the multi-link failures in the network. But the number of the signal generator and the signal receiver need to be installed, and the economic cost is large.

In the process of summarizing and analyzing the above papers, it is found that the cost standard of link failure in all optical networks is not the same as measuring the link failure in the network. In all-optical networks is to detect signal generator and receiver of a number, and the size of the detection channel occupancy of the light spectrum as the standard. The measure in the SDN network is the number of static flow rules established on the switch, and the number of detecting control information.

3 Methodology

3.1 SDN

SDN is a new kind of network technology by separation of control and data network equipment, network abstraction of the application program interface provides to the application layer, so as to construct the open network environment programming [8]. On the basis of various underlying network resource virtualization, to achieve the

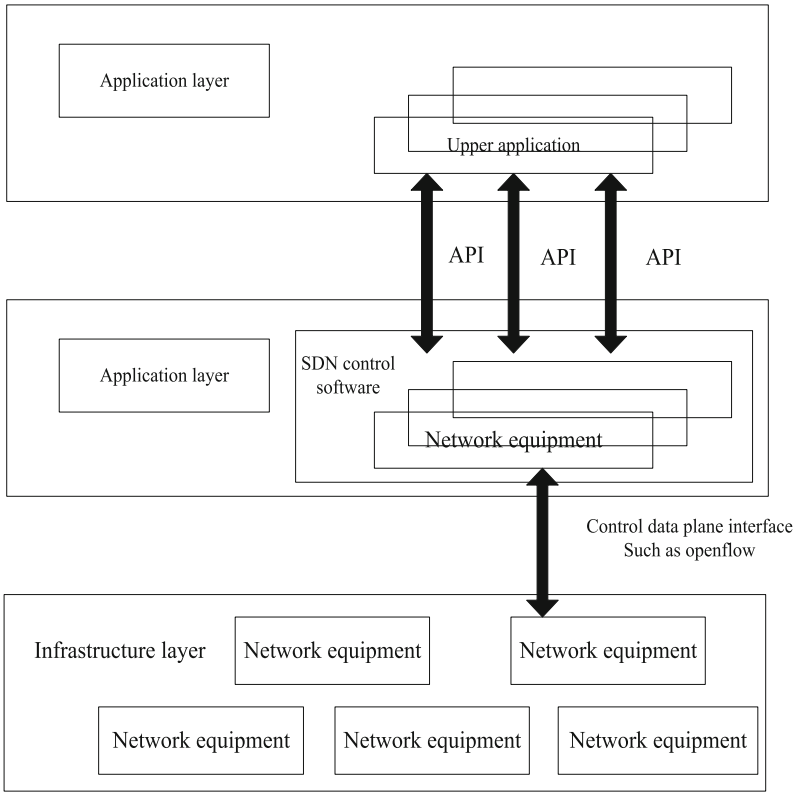

Fig. 1. Architecture of SDN

centralized control and management of the network. Compared with the traditional network equipment, the control ability of network equipment is centralized to the controller. Through the network operating system software-driven approach to achieve a flexible, highly automated network control and service configuration. The logical view of the SDN schema is shown in Fig. 1.

3.2 Tree Decomposition

Tree decomposition approach is to figure each node gradually removed from the drawing, and edge connected thereto, together to save the stack [9]. The rule is deleted from the beginning of the implementation of the lowest node delete. After deleting a node, it need to verify that the two sides connected between the node's neighbors, if not then build such edges.

3.3 Multi Link Fault in Multi Controller Based on Tree Decomposition

3.3.1 The Basic Idea of Link Fault Location Scheme

Firstly, the network topology graph is decomposed into a set of multiple sub graphs based on the tree decomposition of multi degree lossless graph partitioning algorithm. It can be abstracted into a tree structure in Fig. 2(a). In graph (a), a SDN topology graph *G* is decomposed into a number of interconnected sub networks *Gi, Gr. Gn. Gi* represents the i sub network in figure *G*. *G* in the topology diagram with n controller, wherein the *i*-th control domain controllers' *Ci* own one or more of OpenFlow switches in the subnet *Gr* (switch control domain can be distributed simultaneously in the different sub net), the controller *Ci* in order to detect the link status of the whole network, it needs to send a probe message to other subnets.

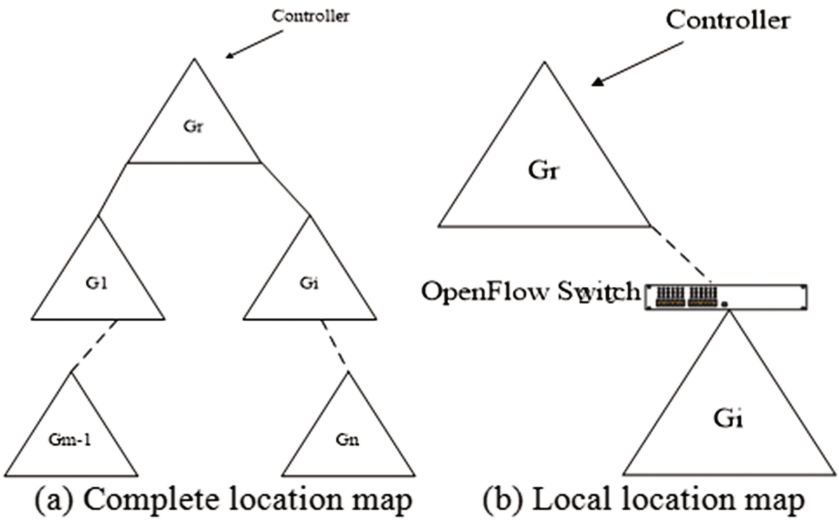

Fig. 2. Scheme of locating link failure

There are two ways of communication between controller and sub network. The first is: If a subnet *Gi* contains the controller in the control area of the switch, the controller chooses the switch as a proxy switch that represents the controller through the switch and the sub network communication. The controller can send the detection information to the sub network *Gi* through the proxy switch. Another way is: If a sub network *Gi* does not contain the switch under the controller *Ci* control domain, *Ci* through the connectivity between the sub network to find a way to reach the shortest path *Gi* border switches. The path to create a link controller *Ci* and *Gi* switch between subnet boundaries, the boundaries of the switch as a proxy switch, the controller sends a probe message to the subnet through the proxy switch. It is shown in Fig. 2(b).

3.3.2 Multi Degree Lossless Image Segmentation Algorithm Based on Tree Decomposition

If the direct method in accordance with the decomposition tree topology graph into a tree topology, each tree node as a subnet have the following problems: Firstly, through the tree decomposition, the number of nodes is too much, each tree node contains a fewer vertex tree, the independence of the tree node is weak, connectivity is too strong. Second, there is no link between the vertices of some tree nodes. In order to solve the problems existing in the sub network generated by the traditional tree decomposition method, a new method of multi degree lossless segmentation is proposed. The algorithm is based on the traditional tree decomposition method adds the tree node merging step.

Abundance lossless decomposition algorithm details are as follows: First, the traditional tree decomposition algorithm is the exploded tree, tree node contains the original set of vertices and edges. Then the tree merging algorithm is used to combine the tree nodes to meet the defined sub graphs.

The specific idea of tree node merging in multi degree lossless decomposition algorithm is as follows: according to the traditional tree decomposition method, a topological graph is generated. Starting from the root node of the tree, using a breadth first search algorithm each node's child nodes. When the child nodes contain the vertices and edges meet certain conditions, nodes of the child nodes and above can do not rely on the idea tree nodes. It can be merged into a meet the definition of a new node. The node and its subtree nodes can also does not depend on the child nodes of the master node and the node above can constitute a new node to meet the definition, which we call the child of the node is the critical nodes. For critical nodes in the subtree of the root node, the same with the above ideas to merge, until incorporated into the tree leaf nodes.

3.3.3 The Maximum Degree-Breadth-First Spanning Tree Algorithm (MBIST) Construction of Polycyclic

For topology *G*, initialize an empty tree *T*. To select the figure *G* to moderate the maximum vertex as the root node r of the tree T. Use the width priority principle to connect the neighbor vertices of the graph with the root node *r* as the node of the root node to be added to the tree *T*, and the degree of the node in the tree is updated. Then, depending on the size of the tree *T* contains a node, select the node degree, its neighbor in the original vertices as its child node is added to the tree (already included in the tree

T neighbor nodes do not need added again). When the neighbor vertices of all the nodes in the same depth of the tree *T* are added to the tree *T*, the degree of the node in the tree *T* is re updated (excluded when calculating the degree of a node has been included in the side of the tree). Finally, repeat the third step operation, until all the vertices in the original image are included in the *T* tree, the end of the algorithm.

3.3.4 Algorithm Performance Evaluation

The performance of the maximum depth first algorithm and other algorithms are compared, and the comparison of the index number of links is balanced and the number of links contains the total number of links. The FST and GST, BFS algorithm was compared. It is shown in the Table 1. For the NSFNET network, MBFST is better than HST and BFST in the uniformity of the ring, it's mainly in the difference of the ring contains the maximum number of links and the minimum number is smaller than the other two algorithms. The total number of links contained in the generated all rings is also less than HST and BFST. For BELLCORE network, MBFST and HST generated balance polycyclic links and the total number of the link are same, but higher than BFST performance.

Table 1. Maximum degree-breadth first multi-cycles, creating an algorithm

Network topology	Algorithm	Single ring contains the maximum number of links	Monocyclic contains the minimum number of links	All total number of links contained in a ring
NSFNET	MBFS	6	5	41
	HST	7	5	47
	BFS	7	3	49
ARPA2	HBFS	13	6	43
	HST	22	6	63
	BFS	15	6	46
BELLCORE	MBFS	7	3	63
	HST	7	3	63
	BFS	9	3	82

3.3.5 Subnet Failed Link Locating Scheme

Link coding. First, the generation of L-N + 1 ring contains a diagram of all links, and the figure of a link may appear in a number of different ring. Let e be a graph $G = (V, \mathrm{E})$ in a link, figure *G* is the ring set ($C_{i\in1}$, I = 1, …, L-N + 1) coverage, which link e may appear in the *k* ring. Secondly, when the controller through the border switch or switches the agent to send all of the rings in the detection signal, if only *e* link fails, the ring contains *k* link *e* cannot detect feedback to the agent switch, and does not include *e* ring link can normally detect feedback information. If the proxy switches to get a feedback loop, the loop is marked as 1. If the proxy switch does not get a feedback loop, the loop is marked as 0. Then, we can obtain a combination of values $v = \{v_{C1}, v_{C2}, \ldots, v_{Ci}, \ldots, v_{CL\text{-}N+1}\}$, where v_{Ci} represents the state of the *i*-th loop has a value of 0 or 1. After using MBFST

algorithm network topology NSFNET polycyclic generated, according to the encoding scheme to each link series of fault codes shown in Table 2. The table on the left represents the polycyclic state code corresponding to the combination of value, the table on the right represents the polycyclic get left state code corresponding to the combination corresponding to the value in the network of the failed link.

Table 2. Coding effect

Information code								Failed link
C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	
0	0	0	0	0	0	0	1	9–13
0	0	0	0	0	0	1	0	10–14
0	0	0	0	0	1	0	0	9–14
0	0	0	0	1	0	0	0	10–13
0	0	0	1	0	0	0	0	1–4
0	0	1	0	0	0	0	0	8–9
0	1	0	0	0	0	0	0	8–7, 4–7
1	0	0	0	0	0	0	0	1–2
1	1	1	1	0	0	0	0	3–6
0	0	0	1	1	0	1	0	4–6
0	0	1	0	0	1	0	1	6–11, 9–11
0	0	0	0	0	1	1	1	6–12
1	0	0	1	0	0	0	0	1–3
0	1	1	0	0	0	0	0	4–5
0	0	0	0	1	0	0	1	12–13
0	0	0	0	0	1	1	0	12–14
0	1	1	0	0	0	0	0	2–8
0	0	0	0	1	0	1	0	4–10

In the above table, only a single link fault code is listed, and the corresponding code word is also listed for multi-link fault. If the code word is still unique, the code word can correspond to a multi-link fault combination.

Acquisition of code value. In order to detect the link state in a subnet, the controller is still sending a probe packet to the proxy switch. But for each subnet, the controller sends only one probe message, not L-N + 1. After receiving the detection information, the proxy switches not only forwards the detection information to a ring in the detection information, but also uses the multicast mode to transmit the detection information to all the loops through it. Use the flow table entry group operating function Openflow switch, when the switch multicast will be sent to a different ring probe packet marked with different ID numbers. When the controller receives the information detected by analyzing the ID number can be returned to the ring this information. A specific process is as follows: when the controller generates the ring to send flow table under static switches, they are set to a static set of actions for each flow table entry. The content of the group is to operate all through the flow table entry packet source *ip* address set to ring ID number. Because OpenFlow switches support group operation is relatively

simple, one of the functions supported is to change the function *ip* packet's source address. In the design of ID, the design of the LAN IP address format. When a ring OpenFlow switch receiving the probe packet through the port number to match the flow table entry, the switch through the flow table entries pre-set group of operations required to forward packet's source *ip* address portion of the ring ID number. It is shown in the Fig. 3.

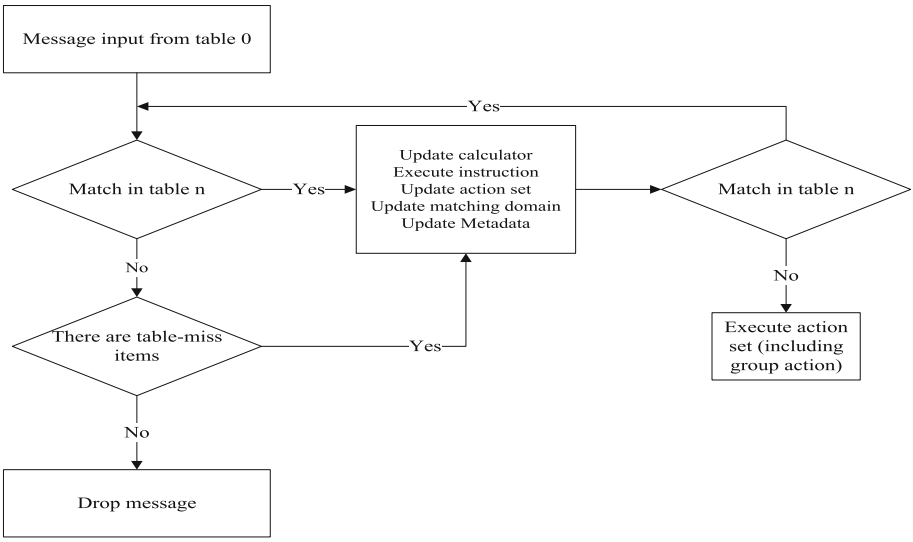

Fig. 3. Procedure of addition of ID number

4 Discussion

Verify that the topology graph is obtained from the topologyzoo web site to obtain the real map, respectively, from the selected SMALLNET, APARENET, BELLCOM, TW_TELECOM four types of network topology. The degree of nodes in SMALLNET is generally greater than or equal to 3. BELLCOM, TW_TELECOM, APARNET in the node degree is generally 2 to 3. The characteristics of BELLCOM and APARNET network topology are different. In that the distribution of node degree, BELLCOM is larger than that of APARNET. TW_TELECOM is larger than the size of BELLCOM and APARNET.

Each tree node (the sub network) is selected as a boundary switch, the controller only needs to send a packet to the border switch. The boundary switch transmits the detection information to the ring which is composed of a static flow table item in advance, and the detection information is carried out by the group operation set in the flow table. Although the probe multicast packet in the process to increase the number, but the whole process is the switch probe information automatically, not sent to the switch controller. Therefore, the tree decomposition method to detect the link fault in the network. It is needed to detect the information tree and the number of border switches,

which is related to the number of the sub network generated by the topology preprocessing. The single-loop formation, double loop generation algorithm based on a genetic algorithm generation algorithm, and an algorithm for generating the second ring based on genetic algorithm are to use the dichotomy probe generation ring link failure, so the number of its probe packets, generated by the number of rings and each ring of the size of the impact.

5 Conclusion

The complete network topology information is required for the controller to carry out the functions such as path selection, load balancing, path optimization, traffic distribution and so on. In the multi controller, if there is a problem of information exchange between controllers, a single controller cannot get the correct and complete network topology information [10–12]. The decisions made by each controller, it may conflict with each other, and the paralysis of the entire network is more serious. For resolving this problem, we propose a method based on tree decomposition to locate link faults in a multi controller. In this paper, we propose a method based on tree decomposition for multi degree lossless image segmentation and the maximum breadth first spanning tree. In this algorithm, the network topology is decomposed into several sub networks, and the degree of vertices in the sub graph can be guaranteed to be more than or equal to 2. In the spanning tree topology, it needs to ensure that the depth of the minimum spanning tree at first. Secondly, in the spanning tree, it needs priority to place original moderate large vertex, then according to the tree generated polycyclic. The experimental results show that the link failure in the network based on tree decomposition method is better than other algorithms in detecting the number of packets and the number of static flow table items. But it is more suitable for the single link fault or chain link fault location. It is weak for more than three link fault location ability.

In this paper, we proposed solutions for a single controller independent to ascertain the status of the network topology, and positioning in the whole network link failures. It needs to be further improved. It has a very good adaptability to dynamic network. At the same time, the most generous - width priority spanning tree algorithm generates a number of multi – loop, it can greatly reduce the number of present static flow table items. And it also can reduce the number of detection information for detecting link failures, but it is not strong enough to locate multiple faulty links. It needs for improvement in the following studies.

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The Protection of Power System Based on Artificial Intelligence

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Abstract. With the development of modern electric power system, high voltage, long distance, and large capacity transmission, national networking have become inevitable. Therefore, the higher requirements have been put forward to ensure the safety and stable operation of the power grid relay protection technology. The bus-bar protection with high reliability, good selectivity and fast action speed has been concerned with the relay protection workers. At present, more and more attention is paid to the relay protection system based on artificial intelligence technology. Based on the analysis of the shortcomings of the traditional bus relay protection, the adaptive and self-learning ability of artificial intelligence technology was used in this paper, the concept of bus relay protection based on artificial intelligence technology was put forward, the related protection model was established, and the simulation experiment was carried out to verify the feasibility of the protection. The model simulation experiments prove that the new model has the advantages of dynamic velocity across the board, which can not only automatically identify the various types of applause, but also can make full use of the system in the real-time information, and better realize the protection of power systems.

Keywords: Artificial intelligence · Neural network · Power system relay protection

1 Introduction

The Power system is the basic industry of the national economy, the security and reliability of power system operation play an important role in the development of national economy, once the accident occurred in the power system operation, it will cause a significant loss of the national economy, and have serious impact on national politics and people's life. The operation of electric power system is safe and reliable, the power quality is high, and the economy is good. The relay protection of transmission line is produced by the development of power technology, the development of artificial intelligence theory and its application in power system, meeting the requirements of the rapid development of the power grid structure and the scale of the relay protection.

In the research on power system protection based on artificial intelligence, the current scientists have achieved good results. Compared with the traditional current protection

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based on neural network, the neural network has obvious advantages, the network can automatically identify all kinds of fault conditions and ensure that the protection of the scope of the forward fault can be reliable action, which makes the current protection break the influence and the disadvantage of the connection mode and the system operation mode of the power network. And the current protection is not only suitable for low voltage network, but also can protect the high voltage network [1]. Adaptive current quick break protection, can adaptively adjust the setting value, which can change the setting value in real time, according to the short circuit type and operation mode of the system. The current protection is not only suitable for low voltage network, but also can protect the high voltage network [2]. By discussing the possibility of using Agent to realize the adaptive setting in the distance protection of the three terminal power supply network, setting Agent to collect running power and the Agent information monitored by circuit breaker status, and comparing with the off-line calculation, the relative ideal value is chosen as a result, which can achieve a certain degree of adaptive adjustment and shorten the time of failure [3]. Adaptive non channel protection of transmission line consists of two action modes, time delay action mode and instant action mode, which are complementary to each other. Delay mode uses the line to accelerate the protection for the switch action information, the instant action mode sets the instantaneous tripping value according to the action of the impedance relay, then uses the switch to correct the error action according to the information of the switch [4]. The research shows that the application of Agent technology in backup protection can shorten the time of backup protection action through the interaction and cooperation between different locations, so as to improve the performance of remote backup protection [5].

The power system is a complex nonlinear dynamic system, which is composed of power generation equipment, transformer, transmission and distribution lines and electrical equipment and so on. According to different power equipment, there are different principles of protection, such as transmission line protection, generator protection, transformer protection, bus-bar protection, reactor protection, etc. [6]. In this paper, based on the transmission line as the research object, this paper expounds the relay protection system of transmission line based on the artificial intelligence technology. The second part of this paper introduces the theoretical basis of the research on the protection of power system based on artificial intelligence, and establishes the method of power protection system based on artificial intelligence. In the third part, the new system protection method is verified, and the results are analyzed. The fourth part summarizes the research of the full text.

2 Preliminaries

2.1 Relay Protection of Traditional Transmission Line

Due to various reasons, the transmission line of the power system may occur in phase to ground fault, short circuit has a great harm to the normal operation of the power system and electrical equipment, accordingly, there must be a corresponding protective device to reflect these faults, and to control the circuit breaker of the faulty circuit, so that it can trip in order to remove the fault. The main protection of the transmission line and

the ground short circuit are current protection, distance protection and longitudinal joint protection [7] (Fig. 1).

Fig. 1. Relay protection tester

Current Protection

Because the principle is simple and easy to implement, the most common form of the current protection is the power protection system, it can be used as the main protection of low voltage network, and can be used as backup protection of high voltage and high voltage network. It is a kind of protection based on the characteristic of the increase of the line current when a short circuit fault occurs in the transmission line [8].

The resistive component of the line is ignored, and then the circuit breaker IQF system is returned, such as the small power of the phase potential of ES. The maximum impedance of the equivalent power supply is x_{smax}, the minimum value is x_{smin}, the distance from the fault point to the IQF protection installation is l, every kilometer line positive sequence is supposed to be x_l. The maximum short circuit current $I^{(3)}_{kmax}$ of three phase short circuit and the minimum short-circuit current $I^{(2)}_{kmin}$ of two phase short circuit are respectively as:

$$I^{(3)}_{k\max} = \frac{E_s}{X_{s\min} + x_l l} = f(l) \tag{1}$$

$$I^{(2)}_{k\min} = \frac{E_s}{X_{s\min} + x_l l} \times \frac{\sqrt{3}}{2} = f(l) \tag{2}$$

The main advantages of the three stage current protection are simple and reliable, and can meet the requirements of fast fault removal in general. Its disadvantage is that it is affected by the connection mode of power grid and the change of operation mode of power system, the whole set value must be selected according to the maximum operating mode of the system, and the sensitivity must be checked by the system minimum

operating mode, which makes it often cannot meet the requirements of the sensitivity coefficient or the scope of protection. When the system operation mode changes greatly or the line length is shorter than the current speed, the protection of the current speed is not protected [9].

Distance Protection

Distance protection is a protection device based on distance measuring elements. Its action and selectivity depend on impedance, reactance and the direction of the local measurement parameters and the comparison results of protected section parameters, however, the impedance and the reactants are proportional to the length of the transmission line, so it also named distance protection. Section III is not only the reserve protection for the main protection of the line, but also the far back protection for adjacent elements [10].

Distance protection is widely used in power system, its main advantages and disadvantages are as follows:

Distance protection in multi power network and even complex network can satisfy the requirement of the action. The first segment of distance protection is instantaneous action, which can remove the protection of the fault in the section I protective area. In a dual power network, if the protection of the first section of the line on both sides of the circuit has overlapping protected areas, then both sides of the line can cut off the overlapping areas of the fault without delay, however, the fault after the first section of the protection zone of the line in the single source radiation network and the fault of the non-overlapping protection zone on both sides of the double power line can't be cut off without delay. The sensitivity of distance protection is better than current protection, and the system is basically not affected by the operation mode of the system. The connection of impedance elements in distance protection is more complicated, and it is required to increase the locking device, so that the distance protection device is more complex, so the reliability of distance protection is low [11].

Longitudinal joint protection

Longitudinal joint protection as the main protection of the 220 kV above the voltage level of the power grid, its advantages and disadvantages are as follows:

Longitudinal joint protection can achieve no time limit speed, and does not need to cooperate with the next line in the selection of the value, which has a good selectivity and sensitivity. In principle, the longitudinal joint protection cannot be used as backup protection for the adjacent lines. Various forms of longitudinal protection are required to have the relevant communication channels to connect the electrical quantities of each side of the line, which can not only affect the reliability of the operation of the protection, but also increase the cost of special channels of investment [12].

2.2 Computational Intelligence Networks

An Artificial neural network is a kind of system engineering, which simulates the structure and intelligent behavior on the basis of understanding the structure and operation mechanism of the human brain, and it is a network connected by a large number of

processing elements such as electronic components. It is a kind of information processing with the brain style, and its essence is to get some kind of parallel and distributed information processing function through the dynamic behavior of the network transformation, and mimics the human brain nervous system at different levels and extent (See Fig. 2). The Artificial neural network has relation with in many subject fields, such as neural science, thinking science, artificial intelligence, computer science and so on [13].

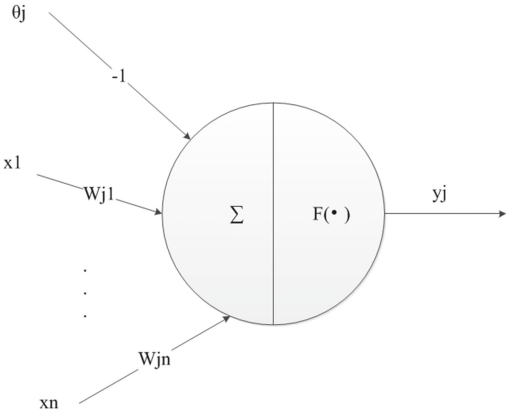

Fig. 2. Structure mode of nerve cell

The input and output of the neuron model is

$$s_j = \sum_{i=1}^{n} w_{ji} x_i - \theta_j = \sum_{i=0}^{n} w_{ji} x_i (x_0 = \theta_j, w_{j0} = -1) \tag{3}$$

$$y_l = f(s_j) \tag{4}$$

Among them, θ_j is called the threshold, w_{jt} is called the link weight coefficient, and f(●) is called the input transformation function.

The characteristics and advantages of artificial neural networks are mainly expressed in the following aspects.

The artificial neural network has the function of self-adaptation, generalization, and nonlinear mapping, which can do highly parallel processing and associative memory.

3 Methodology

3.1 Overview of Multi Agent Systems

The multi-agent system is a frontier subject in today's artificial intelligence. It is an important branch of distributed artificial intelligence research, the goal of which is to change the large and complex hardware and software systems into smaller, mutually

coordinated, and easy-managed system. Besides the agent's knowledge, goals, skills, and planning, the multi-agent research relates to how to make intelligent agents to coordinate actions to solve problems [14].

An agent is one of the main research directions in the field of artificial intelligence, and it is a hot research topic in artificial intelligence and computer science. Agent refers to the group which works together, or a member or a node in the network, Agent can be composed of people, some software or intelligent system.

Several Characteristics of the Agent: Autonomy, social ability or communication ability, reaction ability, and spontaneous behavior.

Agent intelligence is achieved through its structure, Agent structure's problem which need to be solved is: Agent is made up of which modules, how do they interact with each information, how the information about Agent affects its behavior and internal state, and how to combine these modules with software or hardware to form an organic whole [15].

Agent internal system is divided into three categories: active Agent, reactive type Agent, mixed type Agent (See Fig. 3).

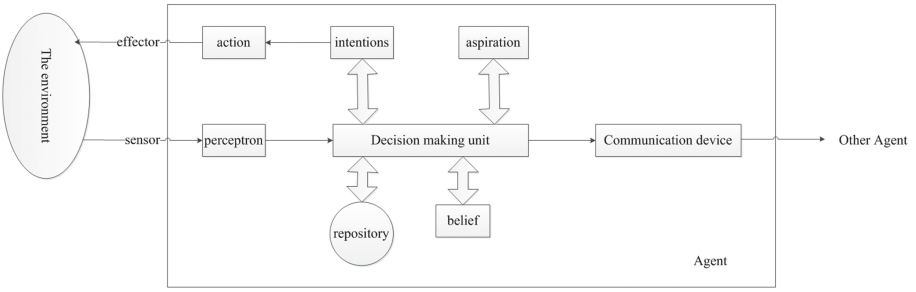

Fig. 3. Agent's model

The multi Agent system is a set of Agent which is composed of a number of interacting and interconnected Agent, each of these Agent is a physical or abstract entity that can act on itself and the environment, and communicate with other Agent, the cooperation ability of which is more effective than a single Agent.

Multi Agent technology is a qualitative leap in artificial intelligence technology, which has the characteristics of autonomy, distribution and coordination, and has the self-organizing ability, learning ability and reasoning ability. Its organizational structure can be divided into centralized control and distributed control.

3.2 Bus Protection System of Power System Based on Multi Agent

Structure system of bus protection based on multi Agent Technology.

In this paper, the bus-bar protection based on multi Agent Technology adopts the result of distributed, which is composed of the coordination layer and the executive layer.

The coordination layer Agent is installed in the substation communication host, it is composed by the Network reorganization Agent and the discriminant Agent. It is responsible for the protection of the site for the information between the interaction and mutual coordination. According to the operating state of the system, the action logic of the bus-bar protection is organized and the corresponding decision is made, and the instruction is transmitted to the relevant executive layer Agent. In addition, it can communicate with the scheduling side, so as to transmit the relevant information of the station to the scheduling side, and accept the scheduling of the instructions in order to complete the corresponding operation.

The execution layer Agent is the protection device of the bus-bar connection element, which is composed of the measurement Agent, the state detection Agent and the trip Agent. The position signal of the relevant circuit breaker and the isolating switch and the AC sampling signal are connected with the protection, but the position signal of the isolation switch is not connected with the protection because of the two bus bars which are connected to the bus circuit breaker. The protection of the connecting element of the bus bar can be protected by the neural network type, and the direction, distinguishing element is composed of a sub network of the positive direction element and a sub network of the opposite direction element. In order to improve the action speed of protection, the fault adopts the half wave Fourier algorithm. During the normal operation of the system, the position signal of the relevant isolation switch and the AC sampling signal are transmitted to the coordinator Agent. When the system fails to start the protection, the output signal of the directional identification element is transmitted to the coordination Agent.

Working principle of bus-bar protection based on multi Agent Technology: For the operation mode of double bus connection, the main wiring is the premise of the direction of the bus into the line, when the fault occurs in the bus area, the short circuit current of each power line is the reverse direction that is from the line to the bus. When there is no fault current flowing through the terminal line, the short-circuit current of the bus circuit breaker is the current from the non-fault bus to the fault bus. When any fault occurs, the short circuit current in the fault line is in the direction that is from the bus into the line, and the short circuit current of the other power lines is the opposite direction.

Because the bus couple is across the two buses, it needs to be specified in the direction of the bus, the general rule is that the positive direction is to point to the second bus from the bus bar, then the short circuit current of the bus circuit breaker is the opposite direction when the bus bar and the lead out line are short circuit faults; The short circuit current of the bus circuit breaker is the positive direction when the second bus and the lead out line are short circuit faults. Therefore, the bus protection can be formed by the difference of the short circuit current direction of each connecting element in the inner and outer fault of the bus bar, in order to prevent the main operation of bus-bar protection. An AC voltage is introduced to judge the operation status of the system in the coordination of Agent.

4 Experimental Results

In the second part, we set up a multi Agent based power system bus protection system, now, we need to experiment, and compare the experimental results with the traditional way of protection, to verify the feasibility and advanced nature of the new system.

Assuming that the conventional protection for the three terminal network configuration is three segment distance protection, the protection circuit of the first segment is full length, and the second section is in line with the adjacent lines. The action time is 0.5 s, Section III as the line near the reserve and the reserve protection of the adjacent line, should be made the whole set according to avoiding the minimum load impedance. Two kinds of protection are simulated by simulation software, and the results are as follows (See Fig. 4, Table 1).

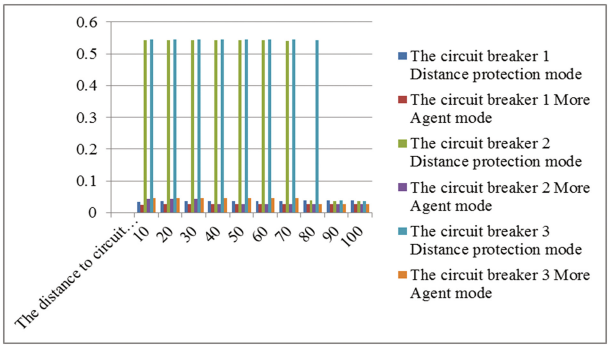

Fig. 4. Distance protection mode and More Agent mode T circuit each side protection action time

Table 1. Distance protection mode and More Agent mode T circuit each side protection action time

	The circuit breaker 1 actuation time (s)		The circuit breaker 2 actuation time (s)		The circuit breaker 3 actuation time (s)	
The distance to circuit breaker (km)	Distance protection mode	More Agent mode	Distance protection mode	More Agent mode	Distance protection mode	More Agent mode
10	0.035	0.025	0.544	0.044	0.546	0.046
20	0.036	0.026	0.544	0.044	0.546	0.046
30	0.036	0.026	0.543	0.043	0.546	0.046
40	0.037	0.027	0.543	0.028	0.545	0.045
50	0.037	0.027	0.542	0.027	0.545	0.045
60	0.037	0.027	0.542	0.027	0.545	0.045
70	0.037	0.027	0.541	0.027	0.545	0.045
80	0.038	0.028	0.038	0.026	0.544	0.028
90	0.038	0.028	0.037	0.026	0.038	0.028
100	0.038	0.028	0.037	0.026	0.037	0.027

As can be seen, for the T access lines, if the traditional three - stage distance protection is used, for each side of the circuit breaker, the instantaneous trip range is very small, for most of the faults in the area, there is always one side or both sides of the circuit breaker which need to be delayed to trip. However, for multiple Agent protection systems, each side of the circuit breaker can be tripped instantaneously at any point in the protected area. Therefore, the experimental results show that, through the collaboration between multiple Agent, the protection can get more useful information, which is conducive to improve the performance of the protection. Compared with the protection system, the protection system has the advantages of full line speed.

5 Conclusions

With the development of national economy and electric power system, the structure of power network in China has become a large capacity, long distance, and a national power grid, which has been developed from the past small capacity, close range and regional power grid. The operating condition of the power grid will be more complicated and changeable, and the possibility of the system failure will be increased. As a link between the power point and the load point, the probability of failure of the transmission line is greatly increased, and the length of the time of failure will directly affect the safe and stable operation of the whole power grid. Therefore, the higher requirements are put forward to ensure the safe and stable operation of the power grid.

Multi agent system is an important branch of distributed artificial intelligence, and its goal is to build a large complex system into small system, which are mutual to communicate and coordinate, and easy to manage. It has the characteristics of autonomy, coordination and distribution. The transmission line protection system based on multi Agent technology is proposed in this paper, which is composed of the organization layer Agent, the coordination layer and the execution layer Agent. Each Agent through the optical fiber communication network carries out the communication and real-time exchange of information about the action information of each side protection to determine the scope of the fault, so as to determine whether or not the relevant circuit breaker trip is required. Compared with the current protection and distance protection, the protection system has the advantages of full line speed, which can be used as the main protection of the voltage level network.

Although in this paper, the transmission line protection system based on multi-agent technology compared to traditional way of protection is well advanced, but to apply it to practice, we need to build more in line with the actual simulation model. At the same time, in this paper, we focus on the application of multi Agent in the transmission line protection, so how to apply multi Agent technology to other parts of the power system is also a subject in the future.

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Intelligent Database Systems

Research on Education and Teaching Resources Management System Based on ASP.NET

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Abstract. The system using popular B/S (Browser/server) of the three layer structure of software architecture, to Microsoft Windows Server 2003 network operating system, based on C# ASP.Net application development environment, for SQL Server 2005 for the background number according to the database while the completion of the development. The system in theory and technology is advanced, it is education and teaching staff provides an editable and can check the background of teaching management platform and guarantee the teaching information resources sharing and effective use. The system is oriented to non-computer professionals, so the man-machine interface design is simple and intuitive, easy to operate, clear, functional and practical. In this paper, we first introduce education and teaching management platform of the development background and significance, followed by the introduction of the development environment of education and teaching management platform and implementation techniques, a detailed description of the system design principle and system components and modules of the database structure, and then expounds the platform realization in three layers of structure solution and test, finally has made the summary and the prospect.

Keywords: ASP.NET technology · B/S framework · Intelligent learning · System design · Database technology

1 Introduction

With the rapid development of computer network technology, the application scope of the expansion, the computer network has penetrated into all aspects of people's lives. In recent years, China's vocational education has been an unprecedented development, the scale of Vocational Colleges and universities have been expanding year by year, the number of students is increasing year by year, teaching resources become increasingly tense. Faced with such a huge amount of information, how to do the standardization of information management, has become one of the key management of the various colleges. The development of the network as the main means of education information on the traditional teaching methods of teaching management put forward new challenges [1]. Management of education and teaching has begun to consider and establish a new

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education and teaching management platform based on the network resources of the school is not limited by space and time constraints (see Figs. 1 and 2).

Fig. 1. Establish the teaching management staff (Chinese version)

Fig. 2. Teaching management background (Chinese version)

This makes the daily management of education and teaching has become an inevitable trend from manual operation to paperless and network development. Students from the matriculation school learning life until graduation, each student's each kind of information will in the admissions office, municipal and registry file. But because some students dropped out or converted professional, and the school's teaching management is still in the manual stage, coupled with the various departments did not communicate

in a timely manner, it will lead to some statistical data is not accurate. Because of the large number of students, the management and query of these data become more and more inconvenient, but also is not conducive to the sharing of data. The education and teaching management platform "is a computer network information management system, used to construct the Daqing technician college daily education teaching information management platform based on the architecture of browser/server (B/s), to realize the remote office, remote office of the school education and teaching management. Meet the school now and in the future to information resources collection, storage, processing, organization, management and utilization of the demand, a high degree of information resources integration and sharing, information resources of centralized management and unified dispatch, the dean's office, municipal and admissions office accurately, and the relevant information and for the exchange of information, teaching management provides a fast and efficient electronic means, and eventually to further improve managers at all levels of management level and working efficiency, reduce the burden of work [2].

2 Key Technologies Involved in the System

C# is developed specifically for the. Net application of object oriented programming language, it allows programmers to rapidly developing a variety of applications on the. Net platform, its inherent characteristics makes it is a kind of high efficient, safe, flexible modern program design language. .NET platform provides a large number of tools and services that can be used to maximize the ability to explore and use computing and communication. Components that are designed using the C# language can be used for Web services, which can be called by Internet, which can be run on any programming language on any operating system. Use namespace (Namespace) to organize programs in C#. We can take a namespace as a class, just like a folder containing files. Microsoft Corp provides thousands of base classes, users can also customize. If you put a base class in a namespace, you can prevent conflicts in the name. Because the use of a namespace can reduce the error and reuse code, and the hierarchical organization makes it easier to spread a member of a program to another program. When accessing a database on a ASP.NET page, you need to import the appropriate namespace, which is more convenient to use the ADO.NET class (see Fig. 3). If you are accessing the Server SQL database, you need to import the following classes in the namespace: System.Data and Client System.Data.Sql. Web application provides dynamic information, its architecture is more than three or more layers of the browser/server (Browser/Server, referred to as B/S) structure. Here the server refers to the Web server and the database server, all the applications are stored in the Web server, the client's identity can determine the contents of the browser display [3]. Through the database server to distribute a large amount of information on the Web server for dynamic management, so that the published information is interactive, dynamic and real-time.

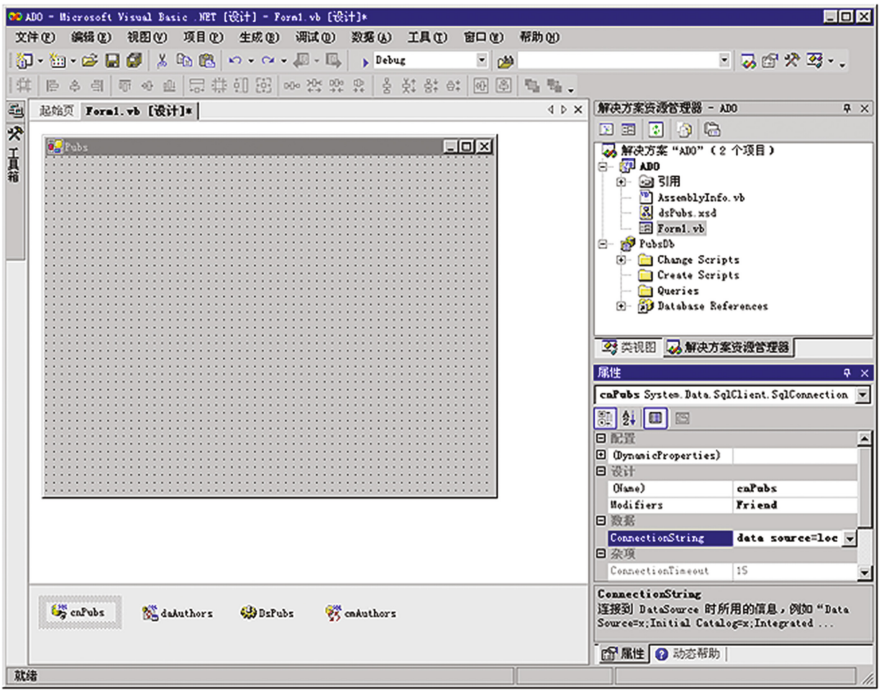

Fig. 3. ADO.NET platform design (Chinese version)

2.1 ASP.NET Overview

ASP.Net is a part of the .Net framework, is a Microsoft technology, is a kind of embedded in a web page script can be executed by the Internet server server-side scripting technology, it can be in via HTTP requests the document again on the web server dynamically created them. Refers to the Server Pages Active (dynamic server page), running in IIS (Information Server Internet services, is the development of Web Windows server) in the program. ASP.Net is the predecessor of the ASP technology, is in the IIS2.0 debuted (Windows NT 3.51), at that time and ADO 1.0 with the launch of, IIS 3.0 (Windows NT 4.0) to flourish in the become server-side applications popular development tools, Microsoft is special for it to create a VisualInter dev development tools, between 1994 and 2000, ASP technology has become one of the key technology of Microsoft to promote Windows NT 4.0 platform, tens of thousands of ASP website this time began springing up appear in the network (see Fig. 4). It's simple and highly customizable, and it's one of the reasons for its rapid rise. However, the shortcomings of ASP also gradually emerge: process oriented programming approach, so that the difficulty of maintaining a lot of maintenance, especially large ASP applications. Interpretation of the VBScript or JScript language, so that the performance can not be fully played. Scalability due to the infrastructure less constrained although COM components available, but the development of some special functions (such as file upload), not from the built-in support and need to seek control of third-party controls.

Fig. 4. ASP.NET startup interface

2.2 Database Technology

In today's connected world, data and data management system must be always available to users and to ensure the safety, the SQL Server 2005 within the organization of the users and IT professionals from reduce application downtime and improve the scalability and performance, the more closely the safety control of benefit. Server SQL 2005 also includes a lot of new and improved features to help the IT team work more efficiently. SQL Server 2005 through provide an integrated management console to manage and monitor the SQL server relational database, integration services, analysis services, reporting services, notification services, and distributed servers and database on the SQL mobile and can greatly simplify the management of complexity. Database administrators can also perform the following tasks: write and execute queries, view server objects, manage objects, monitor system activities, view online help. Server SQL management tool set includes a T-SQL, MDX, XMLA and Server Mobile SQL version, etc. to complete the preparation, editing and management of the script, the storage process of the development environment. The management tool set is easy to integrate with source control, while managing the tool set also includes a number of tools that can be used to schedule Server Agent SQL operations and manage maintenance plans to automate daily maintenance and operation tasks. Management and scripting are integrated into a single tool, while the tool has the ability to manage all types of server objects, providing a greater productivity for database administrators [4, 5].

2.3 Introduction to B/S Architecture

B/S structure (Browser/Server, browser/server mode), WEB is the rise of a network structure mode, WEB browser is the client's most important application software. This model unifies the client, the system function realizes the key part to the server, has simplified the system development, the maintenance and the use [6–8]. The client just installs a (browser English ['bra a Z. ['Bra an z) browser, such as Netscape Navigator or Internet Explorer server installation of SQL server, Oracle, MySQL database. The browser through the Server Web with the database for data interaction. Because of the various problems existing in the Client/Server structure, people put forward a kind of

application system structure browser/server (Browser/Server) structure with three layer mode (3-Tier) on the basis of its original structure. Browser/Server structure is the rise of the Internet, a kind of improvement on the structure of Client/Server. In essence, the browser/server structure is a kind of client/server structure, it can be regarded as special cases of a by the traditional two-layer client/server structure mode development of three layer model client/server structure on the web application [9, 10]. Easy maintenance and upgrade. At present, the software system has become more and more frequent, and the product of B/S architecture is more and more convenient. For a slightly larger unit, system managers if needed in the hundreds or even tens of thousands of computers running back and forth, efficiency and workload is imagined, but a B/S structure of the software only need management server, all the client browser only, do not need to do any maintenance. Regardless of the size of the user how much, how many branches will not increase any workload of maintenance and upgrade, all the operation need only to the server; if it is remote, only need the server to connect to the network can realize remote maintenance, updating and sharing. So the client is more and more "thin", and the server is more and more "fat" is the main direction of the development of information technology in the future. In the future, software upgrades and maintenance will be more and more easy, and the use of it will be more and more simple, this is the user's manpower, material, time, cost savings is obvious, amazing. Therefore, the way to maintain and upgrade the revolution is the "thin" client, "fat" server (see Fig. 5).

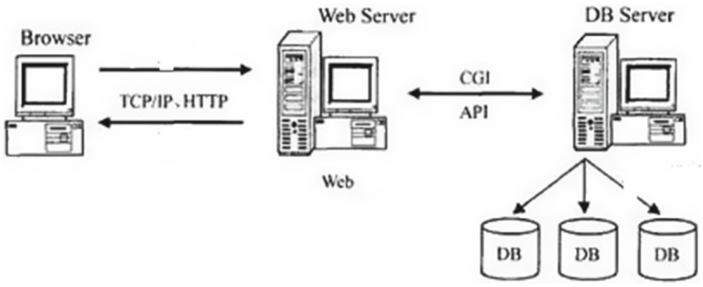

Fig. 5. Schematic diagram of B/S architecture

3 System Implementation

System software commonly used in three layer structure is whole business is divided into the presentation layer, business logic layer, data access layer, and some even have to carefully, through the decomposition of the business details and different function code spread out, is beneficial to the design and development of the system, but also conducive to the maintenance and expansion of the system. Layered structure is a solution to solve a certain problem. In many cases the development is to reuse some of the common things, will put some of the layers are used to abstract out. If we separate the data object entities and methods in order to deliver the data in multiple layers, such as a model. Some common general auxiliary class methods and tools, such as data validation, cache processing, encryption and decryption processing, etc., in order to let each layer between reuse and

separate out, used as a separate module, for example calling for common. Every Web application has to store a number of settings related to the application, which it uses to run. The Web.config file system configuration of the database connection with the relevant information, it is a XML file, located in the root directory of the Web site. Directory management interface regcatalog.aspx call business logic layer System. Cs Catalog class implements the directory information management, business logic, the class access data access layer class DB.cs Catalogs. Catalogs DB.cs class called database stored procedure Getsys tab, delete catalogs, update catalogs, insert catalog, and realize the database table size opt log query, update, insert, and delete operations.

4 Conclusion

From the development point of view, because this system is the group cooperation development, different people can have different division of labor, so the use of B/S based on the three layer structure. From the application point of view, the system has a good scalability and maintainability, but also increased the security of the database and the background application system. Moreover, the three tier architecture can support the distributed computing environment better. User login information is stored in the log, can be found in a timely manner to solve the root causes of the problem. User center, unified management, decentralized control, each function module, the role and the user can be arbitrarily combined to meet the needs of various users. The use of tree type directory structure makes the function of each module clear and easy to use.

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The Design and Implementation of an Online English Testing System Based on MVC Model

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Abstract. In the software engineering system, the system needs analysis, overall design, detailed design and the final realization of the system to ensure effectiveness. Firstly, the paper introduces the background and significance of an online examination system, the development at home and abroad, as well as the development trend in the future. Using the unified modeling language, the function of online examination system is described, and the use case diagram, sequence diagram and activity diagram are given. Then the paper puts forward the overall feasibility, design scheme of the online examination system based on MVC model, and introduces the working principle of the MVC model involved in the online examination system in detail. Combined with the analysis of the online examination system, according to the hierarchical thinking is designed in this paper is composed of client layer, said layer, business layer, persistence layer and data layer is composed of five layers of software architecture, the architecture made detailed analysis and gives the specific solutions. The system presentation layer and persistence layer are respectively adopted Struts and Hibernate framework, and the business layer is designed and implemented by DAO mode technology. The system also defines the data flow between the layer and layer, which further reduces the dependence between the layer and the layer. In this paper, the relationship between the system data and data is analyzed, the database is designed in detail, and the concept model and physical model of the database are given. And through the Hibernate object relational mapping tool, the Java class and database table mapping, a significant reduction in the use of SQL and JDBC data processing time, to achieve the data persistence.

Keywords: Online examination system · MVC model · Intelligent examination · Filtering technology · Cache technology

1 Introduction

With the development of computer network and the gradual popularization, information, network has become the inevitable trend of the development of modern society. Internet technology has penetrated into traffic, economy, education and other industries, especially in universities and technical secondary schools, the construction of campus network has gradually improved, most of the candidates have the use of network tools for information exchange and assisted learning ability. The development of modern

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distance education, which is the main means of Internet, has become the trend of the development of education (see Figs. 1 and 2).

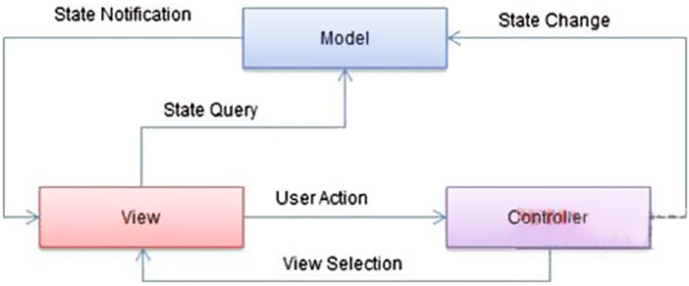

Fig. 1. MVC diagram

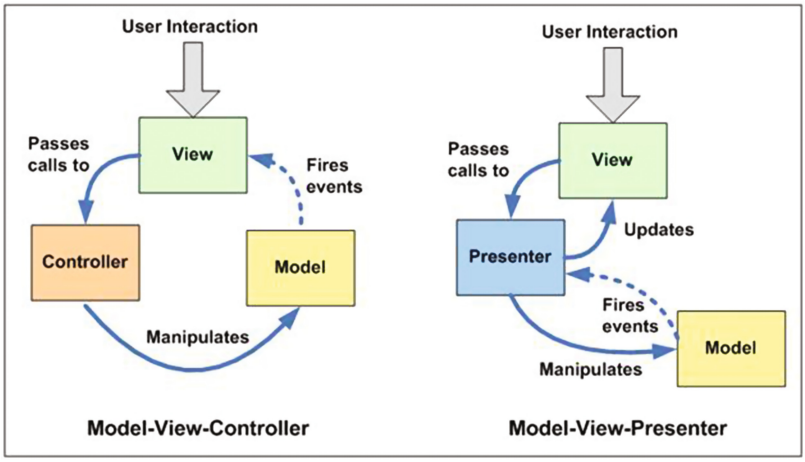

Fig. 2. MVC and MVP diagram

In China, the Ministry of education put forward the implementation of "modern distance education project", the formation of open network education [1], the construction of a lifelong learning system. The combination of the Internet and modern education is the need of modern education and the need for teaching practice reform. This to improve teaching efficiency, improve the level of scientific research and teachers to change their way of thinking has an inestimable role and prompting candidates to fully use all available resources to improve their cognitive ability, expand their horizons, improve the ability of innovation, improve the efficiency of learning. In our country, the examination has been one of the most important links on the school education activities. However, for a long time school examinations are by pen and paper answer the traditional examination, and now many schools are still widely used this kind of exam, Internet resources cannot be fully utilized. In the traditional test methods and test organization to through a number of links, including the teacher's questions, printing time,

examination, teacher marking, statistics of the grade, spent a large amount of manpower and material resources, and in the process of marking system is also very easy to appear human negligence, cause an error, cannot guarantee the examination complete the fairness and justice of. And with the examination questions and the number of candidates is increasing and examination requirements of continuous improvement, organization of the examination of the workload is more and more big, cost is also more and more high [2–5].

2 Key Technologies Involved in the System

First to according to the specialized subject, to establish the corresponding data, in a different professional exam, the teacher can according to knowledge points corresponding to the questions, and at the same time the answer to the given topic. The topic type choice, non title and subjective questions. Teachers on the topic to choose the item in the corresponding data, through exam teachers to edit the corresponding examination questions change. The teacher can also manage the corresponding question bank. Before the exam, the teacher can take questions in the examination question bank, carry on the examination paper. In the process of generating test paper, the need to be able to set up a different set of professional papers is open, and the professional candidates participate in the examination, the non professional candidates are not able to participate in the exam. Test paper, also need to set the test time and the test state, which is open or not open, open state of the test takers can see, not open state of test takers is unable to see the. At the end of the examination, it is also required by the computer automatically according to the answers to the questions to automatically judge. Teachers need to have all kinds of authority to edit and modify the test paper. According to the above system development requirements, according to the object-oriented software development requirements, we use the use case diagram to describe the functional requirements of the system, the functional requirements of the system will be decomposed into each system use cases. A use case describes a form of interactive system. In the system, there are different types of users, each type of user to perform system functions in different subsets of features, the different types of users is called roll. An external entity, which is used to describe the function of the system, can be a user, or an external system. The system determines the user, role, including three categories: administrators, teachers, candidates [6–9].

2.1 MVC Design Pattern

Full name of MVC is a model view controller, is the abbreviation of model (model - View - controller (controller), a model of software design, with a business logic, data, interface display separation method of organization code, business logic are aggregated into a single component, improved and individualized customization of the interface and user interaction at the same time, do not need to re write business logic. MVC has been developed to map the traditional input, processing and output functions in a logical graphical user interface. As technology continues to progress, more and more ways are

needed to access the application. MVC mode allows using a variety of different styles of view to access the same server code, because multiple views can share a model. It includes any web browser (HTTP) or wireless browsers (WAP), for example, the user can through the computer can also through the phone to order a product, although the means that order is not the same, but ordering of products is the same. Because the data returned by the model is not formatted, the same component can be used by different interfaces [10–15]. For example, a lot of data may be expressed by HTML, but it is also possible to use WAP to represent, and these indicate that the command is required to change the implementation of the view layer, and the control layer and the model layer without any change. As the data and business rules have been separated from the presentation layer, so you can maximize the reuse of the code. The model also has the function of state management and data persistence processing, for example, based on the conversation of shopping cart and e-commerce process can also be used by Flash or wireless networking applications (see Fig. 3).

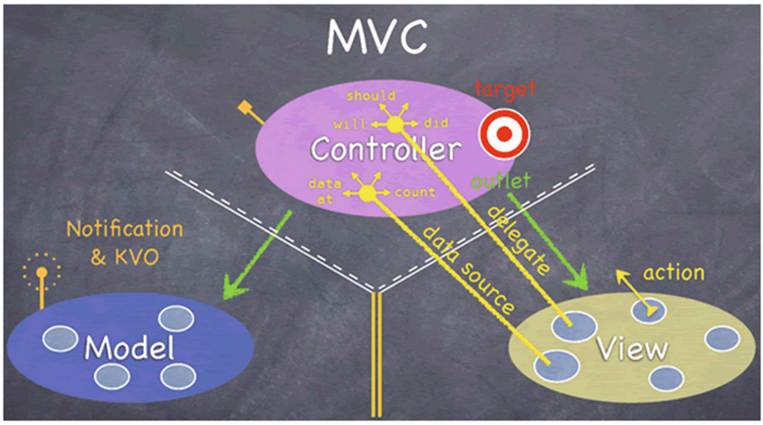

Fig. 3. Schematic diagram of MVC mode

2.2 Hibernate Technology is Introduced

Hibernate is an open source object relational mapping framework, it of JDBC is very lightweight object encapsulation, it will POJO and database table to establish the mapping relation is a fully automatic ORM framework, hibernate can automatically generate SQL statements, are carried out automatically makes Java programmers can be arbitrary use of object oriented programming thought to manipulate the database. Hibernate can be applied in any use of JDBC occasions can not only used in the Java client program, can also be used in the servlet and JSP Web application, is the most revolutionary, hibernate can replace CMP in application of EJB of J2EE architecture to complete the task of data persistence (see Fig. 4).

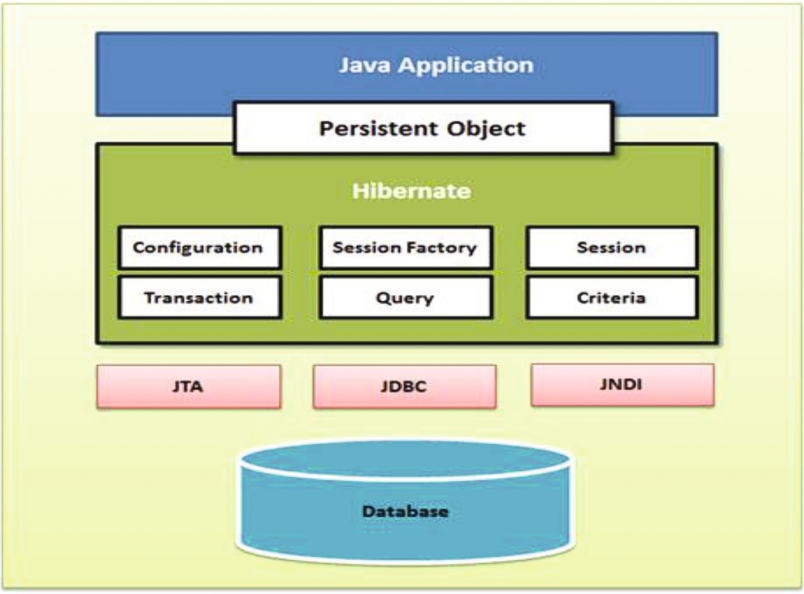

Fig. 4. Schematic diagram of Hibernate structure

2.3 DAO Technology Introduction

DAO Data Access Object data access interface, data access: the name suggests, is to deal with the database. In the middle of business logic and database resources. In the core J2EE mode is introduced in this DAO mode: in order to build a robust J2EE application, all of the data source should be the access to the operation of the abstract package in a public API. Programming language, is to establish an interface, the interface defined in this application will be used in all transactions. In this application, when you need to interact with a data source, you use the interface, and write a separate class to implement this interface in a logical correspondence to this particular data storage. DAO (data access object) is an application programming interface (API), which exists in Microsoft's Basic Visual, which allows the programmer to request access to Microsoft's Access database. DAO is Microsoft's first object-oriented database interface. DAO object closed the Jet function of Access (see Fig. 5). Through the Jet function, it can also access other structured query language (SQL) database.

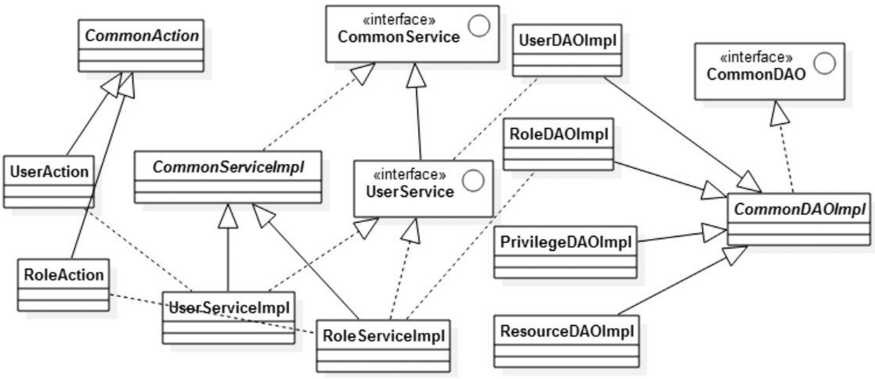

Fig. 5. Schematic diagram of DAO structure

3 System Implementation

The database system is the core and foundation of the whole online examination system, and it is also the key to the design and development of the system. The database system to the large amount of data in the online examination system according to certain logical model to organize and provide data storage and retrieval functions, help system timely, convenient in obtaining the required information. Therefore, the database design must follow the integrity, consistency, reduce the redundancy and other design principles, good database design is the system to improve the operational efficiency of the security. The database concept design of the online examination system is to describe the entities and their attributes, and the relations and constraints between entities in the real test process through the establishment of the conceptual model. Conceptual model has a very flexible semantic expression ability, easy to communicate and understand. The basic theory of the conceptual model is the entity relation theory, and the basic concepts and the relation type of the conceptual model are explained. Through the implementation of the operation of persistent class objects, the logic of the upper layer is not concerned with the details of the underlying implementation of the persistence layer, and more emphasis on the implementation of business logic. User login system, according to the administrator, candidates, teachers three different roles, by entering the user name, password and verification code to log on, after logging into the interface of their respective permissions. The question library module is mainly used by teachers to create questions, and classification management, resulting in the process of test paper from the question bank. This module mainly includes creating the question bank, the management question bank [5], the creation examination question and the management question function. Teacher user login system, you first need to create a database, and then in the corresponding question bank to create questions.

4 Conclusion

The purpose of developing the online examination system is to make full use of the resources of the campus network, to effectively reduce the cost of organizing the examination activities and to improve the efficiency of the examination. The system is an analog display examination of all aspects of the design and development of, in line with the characteristics of the examination activities and conforms to the development direction of the current high-level network examination, has the rich, interactive, simple operation, suitable for teachers and students, for teachers and students provides a test evaluation platform.

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Design and Practice of the Competition Schedule Arrangement System of Swimming Sports Based on Artificial Intelligence

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Abstract. The wide application of computer technology in the field of sports has solved the problems in sports event management such as large amount of workload and complicated data. However, the study on the race scheduling system for the characteristics of the swimming sports is not mature enough. Based on this, this paper designs a swimming, sports competition schedule system based on artificial intelligence. On the basis of a brief analysis on the problems existing in the current swimming competition schedule arrangement, the system is designed on the windows 7 operating system and uses SQL Server 2008. Its communication interface adopts the TCP/IP protocol, and then the paper demonstrates the system architecture, and presents a detailed description of the presentation layer, business logic layer and data access layer in the system. In addition, the system database is designed with Designer Power to avoid the redundancy of database information, and 8 data tables are set up to store all the data in the system. The experiment results show that this system can reduce the input of manpower, material resources and financial resources, improve the competition management level and work efficiency, and to a certain extent, it achieves informatization and automation of management.

Keywords: Swimming competition · Schedule arrangement · Computational intelligence · Databases

1 Introduction

With the development of computer technology and artificial intelligence technology, the informatization and automation of sports event management have become the development trend. The operation of sports events is a process, and the main body of operation executes planning, organizing, leading and controlling functions in the midst of the event management process. Among them, as one of the most important parts, the organization function has been receiving heightened attention. For the most important and difficult part of the competition arrangement in all kinds of competitions, a lot of researches have been made. Diao Zaizhen [1] et al., applied computer virtual reality technology in 2005 to develop a collective competitive project scheduling system, the system has the characteristics of visualization and it can be edited. Shenling Niao [2] in

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2008 proposed short track speed skating competition schedule arrangement method and process, which provides a theoretical basis for the research on the layout system of sports competition. Yang Jian [3] et al. designed the round robin game scheduling method based on the database and computer technology in 2012, to a certain extent, it achieves the information management of the sports meeting. Zheng Wenjing [4] in 2012 designed the schedule of the grassroots competition activities based on the special characteristics of the organization and management of the table tennis match. Zhou Yiping [5] in 2013 designed the schedule of the track and field competition for the disabled for the special characteristics of it, in order to improve convenience of the track and field competition for the disabled. Yang Ling [6] in 2015 applied the theory of congruence to a single cycle of competition in the table layout, the method greatly improves the efficiency of the game management.

However, most of the current events arrangement systems research mainly are concentrated on the large-scale events. The research on small and medium-sized sports contest arrangement system is less, and in the era of the national movement, small and medium-sized sports have been receiving more and more attention. Especially in the swimming competition, there exist problems like heavy workload and complicated data in the scheduling arrangement. And the traditional manual scheduling method costs a lot of manpower, material and financial resources, which has a heavy workload and is very error-prone, therefore, combined with swimming competition rules, the simplification, automation, network of the race scheduling work has become a research focus to save manpower, resources and time, and to improve the management level and work efficiency of the event.

Based on this, in order to solve the problems in the work schedule of the swimming competition such as huge workload and complicated data and other issues, this paper designs a swimming sports competition schedule based on an artificial intelligence system. Section 2 first introduces the problems existing in the artificial intelligence techniques and the sports competition management, Sect. 3 introduces in detail the design process of swimming, sports competition schedule arrangement system based on artificial intelligence, in Sect. 4 experimental test of the system is conducted, in Sect. 5 the conclusion is made.

2 Existing Condition

2.1 Sports and the Layout Management

Sports is a special event, providing competition product and related services, its scale and form is restricted by competition rules, traditional customs and many factors, with project management features, cultural background and market potential, it can meet the needs of different participating bodies to share experience, and to achieve multiple goals and objectives. It has influence on the society and culture, nature and environment, political and economic, tourism and other multiple areas, which can produce significant social benefits, economic benefits and comprehensive benefits [7]. In short, sports event is the organized special time in the uniform rules, time and place and in the same conditions, which takes sports programs as the main content, and contest

Fig. 1. Sports event management

achievement as the outcome standards. This is the basic elements constituting the sports events [8] (Fig. 1).

Although there are different kinds of sports events, but first of all, it has competitive function, as well as the entertainment function and social function [9]. Economic function: the competition is the core of sports events, therefore, raising the level of sports competition is the core function of sports events. Athletes constantly improve their competitive level and ability and improve the competitive level of ranking through attending sports events to exchange skills [10]. Entertainment function: sports events, especially the Olympic Games and the football World Cup, which has a huge influence, have attracted the attention of more and more people with the high-intensity confrontation and high ornamental value, watching sports events has become an indispensable part in people's daily life [11]. By watching sports events, people not only gain physical and mental pleasure, but only change their lifestyle in the positive direction promoted by the sports spirit such as fair competition [12]. Social and economic functions: sports events can greatly improve the popularity of the host, expand its foreign contacts, establish a good image, enhance the reputation, promote the social and economic development and bring comprehensive benefits to the host country or region [13]. With the development and progress of human society, the improvement of the level of material life, participating and watching sports events has become an indispensable part of people's daily life. Sports event operation management is an important part of the theoretical system of sports events, and it is also the work throughout the organization of sports events [14].

2.2 Artificial Intelligence

Artificial intelligence is an interdisciplinary science. In a broad sense, artificial intelligence is the intelligent behavior of human creation, and intelligent behavior includes perception, reasoning, learning, communication and behaviors in complex environments. The research of artificial intelligence has formed three major schools (Fig. 2; Table 1).

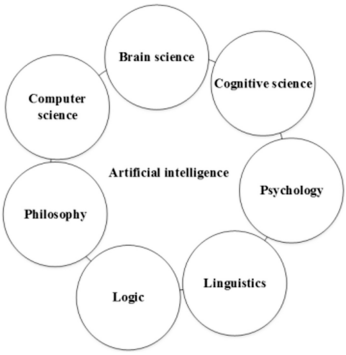

Fig. 2. Artificial intelligence fields

Table 1. School of artificial intelligence

School	Also called	Principle	Origin	Fundamental theory
Symbol doctrine	Logic or computer school	Symbolic operating system hypothesis and the principle of limited rationality	Mathematical logic	It holds that knowledge is a form of information, and it is the foundation of intelligence. The core problem of artificial intelligence is knowledge representation and knowledge reasoning
Connection doctrine	The bionic school or the school of Physiology	Connection mechanism between neural networks and neural networks and learning algorithms	Bionics	It presents a working model of the brain that is connected to the brain, and is used to replace the computer operating mode of the symbolic operation
Behavior doctrine	Evolutionary or Cybernetics	Control theory of perception	Evolutionary	Artificial intelligence can be as gradual evolution as human intelligence, intelligent behavior can only interact with the surrounding environment in the real world and show

With the deepening of research and application, people have gradually realized that the three schools have their own advantages and disadvantages, which should be combined with each other and learn from each other and be integrated. Intelligence has become the development trends, development policies and significant signs of the new methods, new technologies, new products in various disciplines, fields, departments and industries now and later. At present, the wide application of computer technology in the field of sports has solved the problem in sports event management like large amount of workload and complicated data. However, because the special knowledge and system engineering, software development and other comprehensive literacy of developers are not enough, the research on the intelligent management system of sports events is very difficult. In addition, the application of artificial intelligence is mostly concentrated in the field that has higher economic and social benefits, like industry, and research in sports is relatively less and immature. Therefore, artificial intelligence and sports science currently still in an ambiguous position, the intersection of the two also needs a strong bond.

3 Methodology

3.1 The Overall Design of the System

This paper takes the swimming competition in a middle school sports game as an example, the swimming competition schedule arrangement system design is done in a high performance computer with the Windows 7 operating system, and use SQL Server 2008, and the TCP/IP protocol as a communication interface. The system consists of three layers: presentation layer, business logic layer and data access layer.

Presentation layer: it is at the top of the layer and closest to the user. It is used to display data and receive the data user input to provide users with an interactive interface operation.

Business logic layer: it is the intelligent interface between the user presentation layer and data access layer and is responsible for handling the input information and for sending the information to the data access layer to save, and calling function in the data access layer again to read the data.

Data access layer: it provides interface for the data storage, to achieve the data storage and read operations. Data access can access the database system, binary files, text documents or XML documents.

The overall design of the swimming race schedule system is as shown below (Fig. 3).

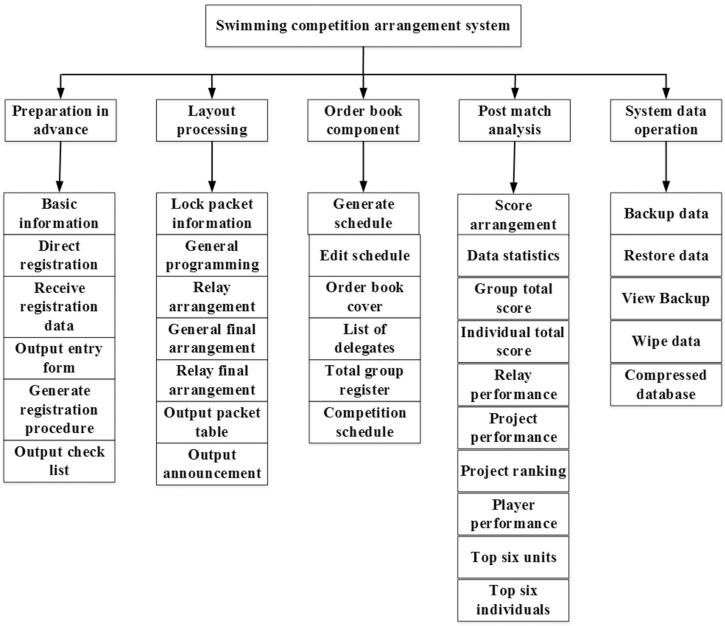

Fig. 3. Swimming competition schedule arrangement system

3.2 The Design and Implementation of Each Function Module

Preparation

The preparation module is mainly responsible for the project basic information before the swimming competition, project time basis, race category, contests, all-around project name, all-around project in each group, cross group total score, integrated team scores, automatic scoring standard, registration work and other settings. The settings are as follows (Tables 2, 3, 4, 5, 6, 7 and 8).

Table 2. Basic information about project

Project code	Project name
1	50 m freestyle
2	100 m freestyle
3	50 m backstroke
4	100 m backstroke
5	50 m breaststroke
6	100 m breaststroke
7	50 m butterfly
8	100 m butterfly
9	200 m individual medley
10	4*50 m freestyle relay
11	4*50 m medley relay

Table 3. Competition group settings

Group name	Group number
Male 12 years old group	01
Male 13–14 years old group	02
Female 12 years old group	03
Female 13–14 years old group	04

Table 4. Competition project settings

Group	Project	Layout mode
Male 12 years old group Male 13–14 years old group Female 12 years old group	50.100.400 m freestyle	A.B group of preliminaries and finals
	50.100 m backstroke	A.B group of preliminaries and finals
	50.100 m breaststroke	A.B group of preliminaries and finals
	50.100 m butterfly	A.B group of preliminaries and finals
	200 m individual medley	A.B group of preliminaries and finals
	4*50 m freestyle relay 4*50 m medley relay	Group final
Female 13–14 years old group	100 m freestyle	Preliminaries - finals
	800 m freestyle	Final slow group - final fast group
	100 m backstroke	Preliminaries - semi finals - finals
	100 m breaststroke	A.B group of preliminaries and finals
	100 m butterfly	Preliminaries - finals
	200 m individual medley	Group final

Arrangement processing

Arrangement function module is mainly responsible for the grouping arrangement and input of results, such as timing results input, arrangement of semi-final and final, and ranking and scoring and updating the data. Details are shown in the following table (Tables 9 and 10).

Table 5. Almighty name project settings

Almighty name	Code	First item	Second item	Third item	Fourth item
Freestyle all round	A	50 m freestyle	100 m freestyle	400 m freestyle	200 m individual medley
Almighty backstroke	B	50 m backstroke	100 m backstroke	400 m freestyle	200 m individual medley
Almighty breaststroke	C	50 m breaststroke	100 m breaststroke	400 m freestyle	200 m individual medley
Butterfly Almighty	D	50 m butterfly	100 m butterfly	400 m freestyle	200 m individual medley
Hybrid Almighty	E	50 m freestyle	50 m backstroke	50 m breaststroke	50 m butterfly

Table 6. All round project settings

Group	All-around project
Male 12 years old group	Freestyle Almighty, backstroke Almighty, breaststroke Almighty, omnipotent Almighty, butterfly Almighty, mixed Almighty
Male 13–14 years old group	
Female 12 years old group	

Table 7. Group total integrated settings

Comprehensive group total score	Code	First class	Second class
Total score of male and female comprehensive groups	A	Total score of male group	Total score of female group
Group A high school group total score	A	Male group A high school group total score*90%	Female group A high school group total score*10
Group B high school group total score	A	Male group B high school group total score*90%	Female group B high school group total score* %10

Table 8. Registration information input table

Unit full name	Abbreviation	Sequence number	English abbreviations
Beijing	Beijing	001	CHN
Chongqing Aasperon Club	Chongqing Aasperon	002	CHN
Anhui Province	Anhui	003	CHN
Shanghai	Shanghai	004	CHN
Guangxi Province	Guangxi	005	CHN
Jiangxi Province	Jiangxi	006	CHN
Fuzhou Swimming Association	Fuzhou Swimming Association	007	CHN
China children's Center	Children's Center	008	CHN
Hainan Province	Hainan	009	CHN
Tianjin	Tianjin	010	CHN
Fujian Province	Fujian	011	CHN
Xiamen	Xiamen	012	CHN
Jiangsu Province	Jiangsu	013	CHN
Wuhan	Wuhan	014	CHN
Hubei fruit lake middle school	Fruit lake	015	CHN
Hubei Province	Hubei	016	CHN
Yunnan Province	Yunnan	017	CHN
Zhejiang Province	Zhejiang	018	CHN

Post-match analysis

The post-match analysis module is mainly responsible for the collation and all kinds of reports in competition, such as the output of individual performance, the output of the single comprehensive performance, the output of all the achievements, the output of the relevant table, the final output.

3.3 Database Design

According to the design of the system function module, the data model and physical data model of the system database are designed by Power Designer fully taking into account the problem of redundancy of database information. All data of 8 data table storage systems are set up. The database table is designed as follows (Tables 11, 12, 13, 14, 15 and 16).

Table 9. Pre competition schedule

Screenings	Date	Items	Group	Project	Match	Start time	Additional time
1	2016.02.08	1	Male 12 years old group	200 m individual medley	Preliminary	08:00.00	0.00
1	2016.02.08	2	Female 12 years old group	200 m individual medley	Preliminary		0.00
1	2016.02.08	3	Female 13–14 years old group	100 m freestyle	Preliminary		0.00
1	2016.02.08	4	Male 13–14 years old group	400 m freestyle	Finals		0.00
1	2016.02.08	5	Male 12 years old group	4*50 m freestyle relay	Finals		0.00
1	2016.02.08	6	Female 12 years old group	4*50 m freestyle relay	Finals		0.00
2	2016.02.08	1	Male 12 years old group	200 m individual medley	Finals	15:00.00	0.00
2	2016.02.08	2	Female 12 years old group	200 m individual medley	Finals		0.00
2	2016.02.08	3	Female 13–14 years old group	100 m freestyle	Finals		0.00
2	2016.02.08	4	Male 13–14 years old group	400 m freestyle	Finals		0.00
2	2016.02.08	5	Female 13–14 years old group	200 m individual medley	Finals		0.00
2	2016.02.08	6	Male 12 years old group	4*50 m medley relay	Finals		0.00
2	2016.02.08	7	Female 12 years old group	4*50 m medley relay	Finals		0.00

Table 10. Grouping list arrangement

Group	Lane	Unit	Name 1	Name 2	Name 3	Name 4
1	1	Yunnan	Yang Tianbin	Lang Zhiqi	Cao Feilong	Wei Qijun
1	2	Zhejiang	Li Ligang	Zhang Shiqi	Zhang Rongzhen	Wang Shun
1	3	Beijing	Bi Ying	Hou Mingda	Xing Daming	Xu Yi
1	4	Shanghai	Xie Zhongjie	Zhang Jie	He Zilong	Pan Longjie
1	5	Fujian	Chen Sikai	Huang Junxiong	Chen Mengxu	Lin Yunpeng
1	6	Fuzhou	Wang Songbo	Lin Shuyang	Yang Weicheng	Wang Xiangyuan
1	7	Jiangxi	Wang Zhonghuang	Hu Yixuan	Zhang Haohan	Ye Yang
1	8	Tianjin	Wang Qi	Tian Dianhao	Xu Zibo	Li Hongyun

Table 11. User table

Field name	Data type	Data length (byte)	Constraint
Account ID	Varchar	12	Not null
Login Name	Varchar	20	Not null
Password	Varchar	20	Not null
Popedom	Varchar	1	Not null
Sex	Varchar	1	Not null Default = admin
Department	Varchar	30	Not null
Class	Varchar	20	Not null
Phone	Varchar	20	

Table 12. Table of competition

Field name	Date type	Date length (byte)	Constraint
Venues ID	Varchar	12	Not null
Venues Name	Varchar	20	Not null
Venues Site	Varchar	20	Not null
Events Name	Varchar	20	Not null
Events Site	Varchar	30	Not null

Table 13. Table of events

Field	Data type	Date length (byte)	Constraint
Events ID	Varchar	12	Not null
Events Name	Varchar	20	Not null
Events Amount	Int	4	Not null The default value is 1
Events Frequency	Int	4	Not null The default value is 1
Race Track	Int	4	Not null The default value is 1
Events Time	Int	4	Not null
Restrictions	Int	4	Not null

Table 14. Schedule

Field name	Data type	Data length (byte)	Constraint
Schedule ID	Varchar	12	Not null
Events Name	Varchar	20	Not null
Events Date	Varchar	8	Not null
Events Place	Varchar	40	Not null

Table 15. Registration form

Field name	Data type	Data length (byte)	Constraint
Entry ID	Varchar	12	Not null
Events Name	Varchar	20	Not null
Students ID	Varchar	20	Not null
Name	Varchar	20	Not null
Sex	Varchar	1	Not null
Department	Varchar	30	Not null
Grade	Varchar	20	Not null

4 Analysis and Discussion

In order to test the performance of the scheduling system based on the artificial intelligence, this paper tests the system. The test results are as follows (Tables 17, 18 and 19):

The experiment results show that this system can reduce the input of manpower, material resources and financial resources, and improve the management level and work efficiency, and to a certain extent, it achieves informatization and automation of the management.

Table 16. Group and score table

Field name	Data type	Data length (byte)	Constraint
Packet Score ID	Varchar	12	Not null
Group ID	Int	4	Not null
Number of Athletes	Int	4	Not null
Events Name	Varchar	20	Not null
Score 1	Varchar	20	
Score 2	Varchar	20	
Score 3	Varchar	20	
Student ID	Varchar	20	Not null
Name	Varchar	20	Not null
Sex	Varchar	1	Not null
Department	Varchar	30	Not null
Grade	Varchar	20	Not null

Table 17. Data entry test

Operation	Desired result	Test result	Conclusion
Basic Information	Be able to input file	Successfully completed	Satisfied
Generate entry form	Be able to produce a registration form	Successfully completed	Satisfied
Direct registration	Be able to enter the player's information	Successfully completed	Satisfied
Generate registration procedure	Be able to produce a separate registration procedure	Successfully completed	Satisfied
Accept registration data	Be able to collect the data from each department	Successfully completed	Satisfied

Table 18. Form test

Operation	Desired result	Test result	Conclusion
Generate schedule	Whether to automatically generate competition schedule	Successfully completed	Satisfied
Edit schedule	Be able to edit the competition schedule	Successfully completed	Satisfied
Entry list	Be able to automatically draw the list of players	Successfully completed	Satisfied
Competition schedule	Whether to generate an edited contest schedule	Successfully completed	Satisfied

Table 19. Users test

Operation	Desired result	Test result	Conclusion
Score arrangement	Can generate group total score table and total score table according to the input	Successfully completed	Satisfied
All grades	According to the entry of the game scores to generate the record of the athletes	Successfully completed	Satisfied

5 Conclusion

With the development of computer technology and the arrival of the information age, the traditional sports event management has faced a great challenge. For solving the problems with the swimming events arrangement such as heavy workload and complex data, based on artificial intelligence theory for guidance and combined with practice, this paper integrated the advanced artificial intelligence technology into the management of sports events, and designed a swimming race seating arrangement system based on artificial intelligence. It focuses on the analysis of the system implementation process. This system serves the competition managers, and is convenient for the contestants and audience, which not only can improve the problems existing in the traditional manual scheduling, achieve regular and efficient processing of event arrangement and enhance the level of event management and operational efficiency, but also can reduce the cost of manpower, material resource and financial resource, and provide a good competitive environment for the participants. However, in this study, the rights management of the system administrator, the event manager and the participating units need to be strengthened and improved.

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Internet of Things

Research on the Operation of Electric Intelligent Automation Based on Computational Intelligence

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Abstract. Computational Intelligence technology has been more and more widely used in electrification, it can not only analyze and calculate the data in the electrification of intelligent automation, but it can also be good controlled by the Computational intelligence methods. Computational Intelligence gets rid of the original control technology, it has made reformation and innovation on the basis of the original technology, which helps realize the handling techniques which cannot be solved by the traditional technology, making the operation of electrification and intelligence automation more and more efficient and automated. According to the analysis of the different advantages of intelligence technology, which has brought further reformation and innovation in electrical engineering. In this paper, the application of Computational intelligence techniques in optimal design of electrical products, the fault diagnosis of electrical equipment and intelligent control in operation process have been discussed. And the result showed that the application in electrical engineering has been more and more popular and it has played an important role in this field.

Keywords: Computational intelligence · Electrification · Fault diagnosis

1 Introduction

The word of "Computational intelligence" was originally brought forward in the Dartmouth Institute in 1956. Since then, researchers have developed many theories and principles, and the concept of Computational intelligence has been extended. Computational Intelligence, which can be abbreviated for AI, is a new technology of science to study how to extend and expand persons' theory, method, technology and application of intelligent system. Computational intelligence is a branch of computer science, it attempts to understand the essence of intelligence, and then produces a new kind of response in the form of human intelligence similar intelligent machines [1]. Researches in this field include robot, speech recognition, image recognition, natural language processing and expert system. Since the birth of Computational intelligence, the theory, technology and application field are expanding unceasingly. It can be imagined that the future of Computational intelligence technology will be a "container" of human wisdom. Computational intelligence is the simulation process about the human consciousness

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and thinking. Computational intelligence is not smart, but could think like people and even act more than the intelligence of people [2].

In this paper, according to the understanding of Computational intelligence, we have deep analysis the meaning and function of Computational intelligence. The progress of technology has led to the development of the operation of the electrification and intelligence automation. The Computational intelligence technology plays an important advantage in the operation of the electrification and intelligence automation. When it comes to Computational intelligence technology, it takes advantage of the characteristic of computer intelligence, it can analysis and calculate the data in electrical engineering and then forming template [3]. It can also adjust the parameters effectively and it also can control the automation. Through the understanding of the Computational intelligence and analysis a large number of applications in electrical engineering; Computational intelligence technology has a very important significance to electrical engineering and it also has been widely used in this area [4]. Therefore, on the basis of the introduction about the conception of Computational intelligence and the advantages of Computational intelligence in the electrification of intelligent automation, this paper analyzed the optimal design of electrical products, the fault diagnosis of electrical equipment and intelligent control in the operation process. And finally presented the result.

2 Materials and Methods

2.1 The Conception of Computational Intelligence

The range of study of Computational intelligence is widespread, involved many different fields. The concept of Computational intelligence was firstly put forward in 1956, it has made rapid growth in relevant field in the past 60 years. The concrete application of Computational intelligence can simply summarized as an Expert System (ES), Computational Neural Net (ANN), Fuzzy Logic (FL), Heuristic Search (HS). Computational intelligence, including three aspects of research: the awareness, thinking and behavior of the machine's.

$$\begin{aligned} f(t) = E(e^{it(\xi_1+\xi_2)}) &= E(e^{it\xi_1} \cdot e^{it\xi_2}) = E(e^{it\xi_1}) \cdot E(e^{it\xi_2}) = f_1(t)f_2(t), \\ f^k(t) &= \int_{-\infty}^{+\infty} i^k x^k e^{itx} p(x)dx = i^k E\left(\xi^k e^{it\xi}\right) \end{aligned} \tag{1}$$

The implementation of Computational intelligence in the computer has two different ways. The first one is the traditional programming technology, which can make the system present the effect of intelligence without considering whether the method and the methods used by the same person or animal. Therefore, this method is called ENGINEERING methods and it has made good results in some field, such as word recognition, computer chess, etc. The other one is the simulation method, it can not only see the effect and the method, but also requires the body and human or biological methods used at the same time. Genetic algorithm and Computational neural network are all belong to the second type. A Genetic algorithm is used to simulate human or biological, genetic

evolution mechanism, while Computational neural network is a simulation of the nerve cells in the brains of human or animal activity [5]. In order to get the same intelligence effect, it is common to use one or two ways at the same time. If the game is simple, it is convenient to use the former method to make detailed regulations by using human program logic. However, if the game is complex, the number and activity space increases, the corresponding logic will be very complex (according to the exponential growth), manual programming is very tedious and error-prone. Once the progress gone wrong, it is necessary to modify the original program, recompile, debugging, and finally to provide users with a new version or provide a new patch, which is very troubling. When the latter method is adopted, the programmers design an intelligent system for each role (a module) to control and the intelligent system (modules) understand nothing, like newborn babies, but it can learn, can gradually adapt to the environment, and finally can deal with all kinds of complicated situations [6]. This system also often makes mistakes, but it can be a lesson when the next run is likely to be correct, at least not wrong forever. Use this method to realize the Computational intelligence, programmers with biological thinking method, difficult to entry point. But once in the door, it can be widely used. The application of Computational intelligence shows the characteristics of automation, it can reflect human consciousness, and strengthen the automation of machine control. However, Computational intelligence is not the intelligence of a man and it cannot reach up to the wisdom of human, so it must be controlled by people. Therefore, the Computational intelligence which is used in electrical automation control complies with the trend (See Fig. 1). Introduction of Computational intelligence in electrical engineering can simulate the human brain to collect information and data, analysis, processing and feedback, by realizing automation production, which can greatly

Fig. 1. The present situation of Computational intelligence

improve the production efficiency, promote industrial structure adjustment and optimization [7].

2.2 The Advantages of Computational Intelligence in the Electrification of Intelligent Automation

(1) Affected by other factors

The original control technology cannot keep up with the development of modern science and technology, data analysis is not comprehensive and cannot realize intelligent in electrical engineering. Affecting by external factors which make it have certain limitation; the control is not accurate in template and parameter and it cannot take advantage of computer to automatic control. However, the Computational intelligence technology has completely replaced the original control technology, and on the basis of its extensive innovation. The technology, intelligence and high efficiency of computer characteristics have been brought into the application of electrical engineering. It can not only get rid of the limitations from the original models, but also can conduct a comprehensive upgrade without specific parameter calculation and it can be analyzed intelligently; not limited by outside factors, eliminate the factors affected by the external force [8].

(2) Easy to adjust the relevant parameters

To adjust the relevant parameters of Computational intelligence, can effectively improve the performance of the intelligence function. Compared with original controller, the Computational intelligence controller will be easier to adjust and study. And the adaptability is stronger, even if there is no guidance from the experts, the Computational intelligence controller can also refer to the reasonable data, using the information about language and response to set. At the same time, the parameters which have been set can also be modified and extended in a convenient and quick way [9].

(3) Have good consistency

The traditional control method is based on the specific design and special goals, so for a particular object, the control result of such control method is very good, but for the other control effect of the other objects will not be able to guarantee. Compared with the original control method, the Computational intelligence in electrical engineering has a good consistency and Computational intelligence technology can occupy more powerful advantages in control technology. According to the understanding of conventional control method, it cannot be well controlled and for the controlled object is not able to well command of its control effectively [10]. But the Computational intelligence owns the advantages that the original technology does not have. Compared with the conventional control method, the Computational intelligence in electrical engineering has a good consistency. To input data to any unknown data in the system can also generate high estimate, some factors even can be ignored. Besides, the intelligent setting process will promote the standardization of the product, ensure that the product has the same performance (See Fig. 2).

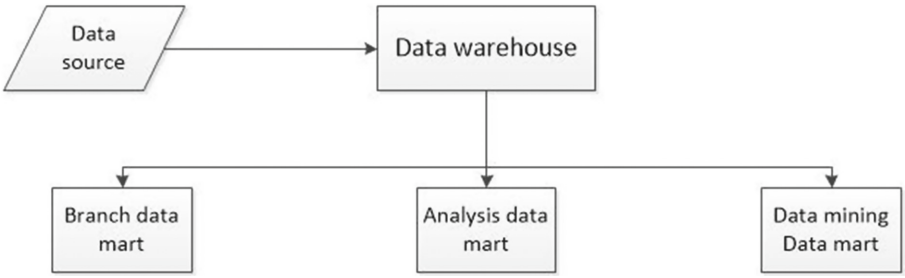

Fig. 2. The traditional control method

3 Results

3.1 Optimal Design of Electrical Products

Optimal design of electrical products is a complex task, it needs to combine the technology, design and experience knowledge together in the design process, which can help products are scientific and practical. In recent years, with the development of computer technology, by adopting Computational intelligence technology to the design of electrical products, which makes the design process is gradually changed from the manual turning to Computational intelligence aided design [11]. Therefore, it can effectively shorten the design cycle of the product and the design of the products is better, practical and scientific. The application of Computational intelligence in electrical products can be shown as follows in the Fig. 3. It has been observed that the Artificial Neural Networks have potential in many common life situations. A significant application is found in [12] where a model was proposed and it simulates the training set [12].

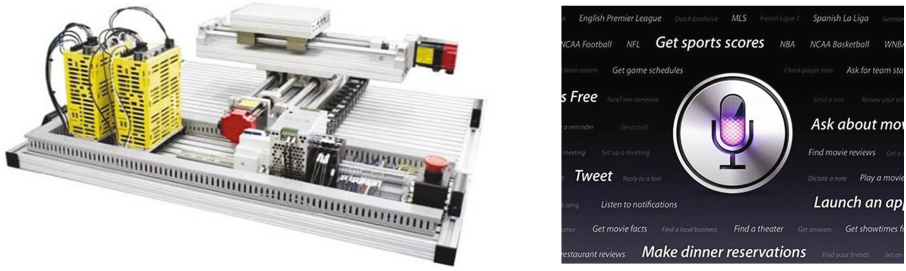

Fig. 3. Application of Computational intelligence in electrical products

3.2 The Fault Diagnosis of Electrical Equipment

When the equipment failure in electrical engineering, Computational intelligence technology can test and then find the reasons and diagnosis;for traditional technology, it cannot accurately investigate the cause of the problem, so the troubleshooting problems cannot be timely resolved. But the Computational intelligence technology occupies a

large advantage in this technology, it can not only find out the causes of the problem but also can intelligent analysis and then diagnose. It can not only increase the efficiency of fault handling, but can also handle the equipment failure accurately. Both effective and safe, intelligent and accurate [13]. In [14], it was found that the factors such as Vibrations, internal stresses, inherent eccentricity, and bearing currents due to electronic drive systems have effective influence on developing the faults [14].

3.3 Intelligent Control in Operation Process

With more and more high requirement of automation, the Computational intelligent control technology will be a development trend in the future, which has been widely used in the operation of electrification intelligent automation. Computational intelligence technology has been widely used in electrical engineering, its development is becoming more and more quickly; facing with the complexity of electrical equipment, the computational intelligence can realize high quality, high standard, high efficiency and high quality control. At runtime, it can control the parameter management, data, etc. In addition, it can help the electrical engineering deal with problems in the automation process. The parameter estimation method includes five basic steps: the first one identifies the process equations with the input variables. They utilize the conservation equations and phenomenological relationships. The second is to find the physical model parameter which aim to see the new parameters [15]. The third is to find the model parameters from the current and recently measured input variables and output variables. The fourth is calculating estimates of the physical parameter from the estimated model parameters. The fifth is concerned about the unexpected situation. By using the above processes it is possible to detect faults.

4 Conclusion

The operation of electrification in intelligent automation, the Computational intelligence technology plays an important role, which can not only to be able to use computer technology to manage, control, and it can also effectively calculate. It provides an effective control technology, ensure the quality and safety, and cost savings; However, Computational intelligence technology is not perfect, there are also shortcomings need to improve and innovate. In its best application in electrical engineering in the optimized, make it can bring more economic benefits in electrical engineering; Computational intelligence technology in the application of electrification of intelligent automation is beneficial to the continuous development of society, it will benefit the development of the enterprise and the development of electrification intelligent automation as well. Consequently, it is a good idea to make the Computational intelligence application in the electric intelligent automation continue to grow.

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Fault Diagnosis and Structure Optimization of Engine Based on Signal Feature and CFD

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Abstract. In view of the close correlations between the working state of engine moving parts and the whole machine structure with the characteristics of the engine vibration noise problem, in analysis of engine vibration noise, and start from the noise signal characteristic in the engine working process, the engine structure and performance has been analyzed, the engine fault types have been obtained by the fault diagnosis prediction method, which has been applied in structural optimization. In order to explore the high efficient and environment protection of the engine structure model, the model and analysis of the whole engine, fan cooling system and combustion chamber were carried out by using the model of sound and vibration coupling and premixed combustion, which is verified to improve the efficiency of the engine and environmental protection by the comparison of different models.

Keywords: Vibration signal · Wavelet transforms · Time-frequency feature parameters · Support vector machine · Localized surface plasmon · Impedance match

1 Introduction

Most of the vibration signals of rotating machinery are non-stationary signals. The time, the frequency analysis method can extract the local information in the time domain and frequency domain, which is suitable for the fault diagnosis of rotating machinery. But the frequency analysis methods of Short Time Fourier Transform (STFT), Wigner Ville distribution, Wavelet Transform and Hilbert Huang Transform have their own defects, so it is urgent to study new methods of fault diagnosis for rotating machinery. Most of the research objects are to extract the vibration features for intelligent recognition, and most of the research objects are to extract the vibration features of intelligent recognition, and then real-time to determine the mechanical failure of the engine, and it is still relatively rare that taking feature signal as fault prediction and optimization method. From the beginning of the structural design, the fault prediction can effectively reduce engine failure rate, so as to improve the design quality, engine design strength and service life [1]. On the basis of the previous algorithm, the mechanical fault diagnosis and prediction technology and CFD

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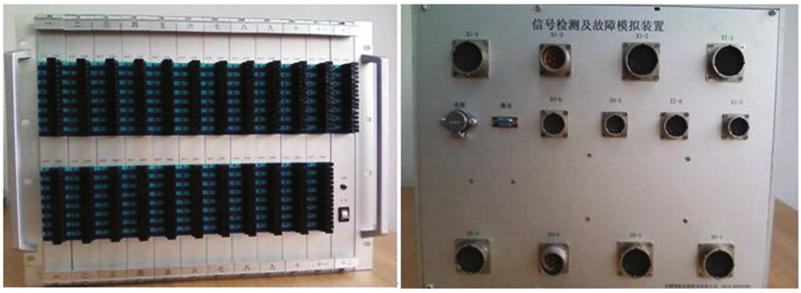

Fig. 1. Signal detection analyzer

simulation technology are applied to the engine structure optimization in this study, the methods of EMD denoising, entropy and support vector machine are used in mechanical fault diagnosis for forecasting and analysis, the model and analysis of the whole engine, fan cooling system and combustion chamber were carried out by using the model of sound and vibration coupling and premixed combustion (see Fig. 1), and the data processing and simulation computational tool of MATLAB software and ANSYS-FLUENT software is used for simulations [2].

2 Feature Extraction Based on Time Frequency Analysis Method

Wavelet transform was proposed by the French Morlet in 1984, when the frequency window is adaptive, so it is called a mathematical microscope. Since the advent of wavelet transforms, the wide range of applications, such as signal frequency analysis, image processing, denoising denoising and edge detection etc. field, wavelet transform in rotating machinery, equipment feature extraction has also been widely used, such as Lin Jing, sun Q, he Xiaoxia using continuous wavelet transform for rolling bearing fault diagnosis, and obtain the good diagnosis effect; Zhang Zhongmin, Dong Feng Shi such as the wavelet envelope analysis of rolling bearing was studied.

Hilbert-Huang transform was proposed by E. Huang Norden in 1998, and it is widely used in practical engineering because of its applicability to non-stationary and nonlinear signal analysis. HHT mainly includes two steps [3]: one, the signal of empirical mode decomposition (EMD), obtained a number of intrinsic mode functions (intrinsic mode functions, the IMF); second, of IMF components of Hilbert transform of the analytic signal after solving the instantaneous frequency and amplitude. Thus we get each component of the spectrum.

3 The Basic Model of CFD Flow Field Calculation

ANSYS-FLUENT is the most commonly used CFD simulation software, fluent three calculation equation of Eqs. (1), (2) and (3), three equations were discrete model can be solved to obtain slurry jet flow field and eddy current distribution.

FLUENT for the continuous phase of the solution process is mainly for the discretization of the three basic equations, the equations of the three equations, including the mass continuity equation, momentum equation and energy equation.

The expression of the mass equation can be written:

$$\frac{\partial \rho}{\partial t} + \frac{\partial \rho(u_j)}{\partial x_j} = 0 \quad \text{j} = 1, 2, 3 \tag{1}$$

In the formula, x is the axial coordinate U axis always flow speed.

Momentum conservation equations can be written.

$$\frac{\partial}{\partial t}(\rho u_i) + \frac{\partial}{\partial x_j}(\rho u_i u_j) = -\frac{\partial P}{\partial x_i} + \partial \frac{\partial \tau_{ij}}{\partial c_j} + \rho g_i + F_i \tag{2}$$

In the formula, P is the static pressure; it is the stress tensor, which is defined as the following:

$$\tau_{ij} = \left[\mu\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right)\right] - \frac{2}{3}\mu \frac{\partial u_l}{\partial x_l}\delta_{ij}, \rho g_i$$

The form of the energy equation for FLUENT is as follows.

$$\frac{\partial}{\partial t}(\rho E) + \frac{\partial}{\partial x_i}(u_i(\rho E + p)) = \frac{\partial P}{\partial x_i} + (k_{eff}\frac{\partial T}{\partial x_i} - \sum_j h_j J_j + u_j(\tau_{ij})_{eff}) + S_i \tag{3}$$

In the formula, $k_{eff} = k_t + k$ reprents for effective thermal conductivity. $J_{j'}$ is a component Diffusion flux j'. The three right of the equation is the thermal conductivity, the diffusion term and the viscous dissipation term. S_h is a source term that includes other volume heat sources and chemical reaction heat. Among them,

$$E = h - \frac{p}{\rho} + \frac{u_i^2}{2} \tag{4}$$

For an ideal fluid, the enthalpy is defined as $h = \sum_{j'} m_{j'} h_{j'}$: for the incompressible gas, it is defined as: $h = \sum_{j'} m_{j'} h_{j'} + \frac{p}{\rho}$. $m_{j'}$ is a component j' of the quality score, the definition of the component j' is $h_{j'} = \int_{T_{ref}}^{T} c_{p,j'} dT$. In which, $T_{ref} = 298.15K$.

F_i is a gravity force and other volume force, F_i also can include user defined source terms or other model source terms.

Fluent equation of continuous phase the discretization of the equations including the finite element method, finite difference points method and the finite volume method, this paper calculated using is a finite volume method, finite volume method is developed rapidly in recent years a discretization method, the biggest feature is a high computational efficiency [4]. Finite volume method (FVM can also be called control volume method, the basic idea of the method is the solution domain is divided into connected to each other, do not coincide with the control volume, and make each grid node around the control volume, the solution of the differential equation of control volume integral [5–8], finally get the discrete equations. The number of unknowns in the discrete equation is the number of the dependent variables on the finite volume. In the finite volume calculation, it is necessary to assume that there is a change law between the grid and the assumption of the grid. From the computational domain selection point of view, the finite volume method is a weighted evaluation of sub - region method, from the pending solution approximation process, finite volume method to discrete local approximation method, but the first method is the basic method of a finite volume method.

4 CFD Simulation Radiation Model

Discrete coordinate of the solution of the model is from a limited solid angle from the radiation transfer equation (RTE). Each solid angle corresponds to the Cartesian coordinates in a fixed direction $\vec{s}$. The discrete precision of the solid angle is determined by the user, and he is somewhat similar to the number of rays in the DTRM model. However, unlike the DO model, the DO model does not have the ray tracing, in contrast, the equation is transformed into the transport equation of the radiation intensity in the space coordinate system. How many (solid angle) direction $\vec{s}$, on how much (radiation intensity) transport equation. The solution method of the equation is the same as that of the fluid flow and energy equation.

In FLUENT, a discrete coordinate model is used to form a conservative difference scheme called finite volume method, which is then extended to unstructured grids.

The DO model is regarded as a field equation, which is regarded as a field equation in the direction $\vec{s}$ of the propagation of the radiation equation (RTE).

$$\nabla \cdot (I(\vec{r},\vec{s})\vec{s}) + (a+\sigma_s)I(\vec{r},\vec{s}) = an^2\frac{\sigma T^4}{\pi} + \frac{\sigma_s}{4\pi}\int_0^{4\pi} I(\vec{r},\vec{s})\Phi(\vec{s},\vec{s}')d\Omega' \tag{5}$$

FLUENT allows the user to use the gray band model to simulate the non gray body radiation. For the spectral radiant intensity, the radiation propagation equation $I_\lambda(\vec{r},\vec{s})$ is as follows.

$$\nabla \cdot (I_\lambda(\vec{r},\vec{s})\vec{s}) + (a_\lambda+\sigma_s)I_\lambda(\vec{r},\vec{s}) = a_\lambda n^2 I_{b\lambda} + \frac{\sigma_s}{4\pi}\int_0^{4\pi} I_\lambda(\vec{r},\vec{s})\Phi(\vec{s},\vec{s}')d\Omega' \tag{6}$$

Among them, λ is for the radiation wavelength, fa_λ is for the spectral absorption coefficient, $I_{b\lambda}$ is the intensity of the black body radiation, the determined by PLANCK law. The scattering coefficient, the scattering phase function, and the refractive index is assumed to be independent of wavelength. Non gray Do a radiation model of the entire spectrum of radiation belt is divided into N wave (length), the band does not need is continuous or spacing. The wavelength interval is given by the user, and this is the value of the vacuum (refractive index $n = 1$). The RTE equation is integral to the wavelength at all wavelengths, so that the transport equation $I_\lambda \Delta\lambda$ is obtained. The heat radiation contained in each waveband $\Delta\lambda$. In each zone, that is the blackbody radiation, the unit solid angle blackbody radiation (force) is as follows.

$$[F(0 \to n\lambda_2 T) - F(0 \to n\lambda_1 T)]n^2 \frac{\sigma T^4}{\pi} \tag{7}$$

Among them, $F(0 \to n\lambda T)$ is for the refractive index of the medium, in the temperature T, the wavelength range of radiation (force) is $0 \sim \lambda$. λ_1, λ_2 is the boundary zone.

In the direction, the total radiation intensity at the position is:

$$I(\vec{r}, \vec{s}) = \sum_k I_{\lambda k}(\vec{r}, \vec{s})\Delta\lambda_k \tag{8}$$

In which, the sum is performed over the entire wavelength range. For non gray Do model boundary conditions is based on the zone boundary conditions (i.e., each zone corresponds to a boundary condition). Within a band, DO model and grey body boundary conditions are the same.

5 The Development Platform of Mechanical Fault Diagnosis System

The function of mechanical fault diagnosis, testing system is signal acquisition, signal processing, fault diagnosis, and so on, which can be used in the design and development of virtual instruments. Virtual instrument (VI (virtual instrument) and the traditional instruments with the same data acquisition, data analysis and processing and displaying the results, but also by the user according to the need to define or expansion, the user can freely combined computer platform, hardware, software, and various application system accessories, to meet the needs of different professional testing, the characteristics of change the functions of the traditional instruments is fixed, and it is difficult to upgrade. VI system from the composing elements, composed of computer, application software and hardware; from the structure mode, with DAQ card and signal conditioning instrument hardware and the composition of PC-DAQ measurement system, GPIB, VXl, serial and field bus such as standard bus instrument hardware group into PIB system, system of VXI bus, serial system and fieldbus system for a variety of forms. No matter what kind of VI system, is the instrument hardware is equipped with a laptop, desktop PC or workstation and other computer platforms,

coupled with the application software and. Therefore, the development of VI system has been fully kept pace with the development of computer technology, but also shows the flexibility of the VI system and strong vitality.

Virtual instrument is the current computer aided testing (CAT) in the field of an important new technology. Compared with the traditional instruments, the main difference lies in the VI's function is defined by the users, and the function of traditional instrument by the vendor defined in advance, the virtual instrument technology than the traditional technology with greater flexibility and superiority of. To the establishment of the mechanical fault diagnosis information acquisition and analysis technology based on the analysis of virtual instrument technology of general test platform, can give full play to the advantages of Virtual Instrument Technology: test analysis performance improvement and function extension only need to update the related software design, no need to buy new equipment, thereby reducing test and development costs; development cycle than the traditional instrument greatly shortened; an open, flexible, can be synchronized with the development of computer, and Internet network and other devices. Ni company development and launched a variety of bus system based on virtual instrument, and it has been widely applied, HP introduced the HP VEE programming, virtual instrument system, the system can provide hundreds of virtual instruments set up the unit and the whole, for the user design and virtual instrument provides great convenience; the Tektronix, Racal companies have launched a variety of bus system based on virtual instrument, greatly promoted the development of the virtual instrument technology. Since the mid 1990s, domestic some universities and research units in the introduction of digestion and absorption of Ni, HP and other products based on, launched a some domestic virtual instrument hardware and software, extent, promotes the application of virtual instrument technology in the domestic.

At present, for the development of machinery fault diagnosis test system platform of language are visual basic, Visual C++ and LabWindows/CVI and LabVIEW software system, but the text programming language professional and strong, not easy to get started and the development cycle is long. LabVIEW, a graphical programming language, integrated data acquisition, GPIB, serial instrument control and signal processing, analysis, signal displaying and saving instrument test system of most of the functions, making design personnel can be freed from the substantial programming effort, so that it can better overall design diagnosis of functional test systems. The virtual instrument designed by LabVIEW can be separated from the LabVIEW development environment, and the end users see the operation panel which is similar to the actual hard instrument. LabVIEW provides the best development platform for advanced testing and instrument software, and has become the industry standard of graphic programming language. The measurement and control system based on LabVIEW is widely used in various fields of scientific research and engineering, including mechanical fault diagnosis system based on vibration signal measurement and analysis [9–11]. Either from the medium the application of virtual instrument technology in the engine, the engine performance test data acquisition and monitoring system; Wang Leqin etc. The comprehensive characteristic of the pump test system was developed based on the LabVIEW platform [12–15], the test conditions in regulating aspects have a good effect; virtual instrument technology also is applied in the performance test of

screw pump and refrigeration and air conditioning monitoring and other fields, made a lot of useful experience.

6 Conclusions

To sum up, the project is to solve the following problems:

(1) Based on signal feature extraction method for engine fault diagnosis, the fault type statistics, the type of fault prediction method is put forward, according to the types of common faults, it will put forward rational optimization scheme of the structure of the engine.
(2) By using the acoustic vibration coupling analysis, the structure of the engine and fan cooling system was optimized, and the simulation model was established by using CFD.
(3) The structure of the engine is improved by referring to the current innovative design of the engine combustion chamber model, and the CFD simulation method is used to verify the various optimization schemes.

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A Study on the Application of Computer Simulation to Physical Activities

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Abstract. Currently, national teenagers' physical qualities slump sharply; therefore, traditional physical activities and teaching methods cannot achieve satisfying results limited by time and space. Under such a condition, it can make breakthroughs to introduce computer simulation techniques. The computer simulation technology can establish a simulated physical activity through building a simulative system in vision, hearing and other aspects. Through simulated activities, such a technology can avoid the imbalance of time and space, as well as teach students according to their own characteristics so as to improve the feasibility and effectiveness of activities. This work introduces the application of computer simulation in physical education from its features and functions, as well as analyzes conditions that may occur during physical activities and computer simulation techniques by examples. The work provides a solution after analyzing and interpreting a typical case in the final part, as well as analyzes advantages and application points of the simulation technology considering general problems in physical education. The result shows that the simulation technology can be applied in physical education and provides valuable references.

Keywords: Computer simulation · Physical activity · Applied research · Virtual teaching

1 Introduction

With the continuous development of modern scientific techniques, computational techniques have been widely used in social politics, economy, culture, education and other aspects [1]. Although physical education has been continuously developing, in traditional college physical activities, students have less training time and low training initiatives; therefore, both their physical qualities and training awareness have not only improved but also declined. The result of physical education is not satisfying [2]. Therefore, researchers need to make good use of technological means to continuously improve teaching qualities under the context of overall new teaching reform policies. The arrangement and application of those means in practices can relieve students' "auditory fatigue" to a large degree in teaching and change the singe teaching method that students learn only from teachers' interpreting [3, 4]. The computer simulation technology is defined as a comprehension of those techniques. As a new-type scientific field, the

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computer simulation technology refers to an interaction of massive subjects, for example, computer graphics, mechanics of machinery, materials science, and sensor technology. It has greatly influenced the educational pattern of colleges and has become a most valuable and useful "star" technology. In college physical education, physical educational mode plays an essential role [5]. The computer simulation technology is a latest application of modern information techniques to simulation teaching methods. Taking its unique features such as immersion, interaction and conception as staring points, the computer simulation applies techniques of computer graphics, simulation, multimedia, artificial intelligence, computer network, parallel processing, and multi-sensory to make people be immersed in human-computer interactions generated by computers and realize real-time interactions in a natural way such as languages, gestures and gravity sensors so as to create a humanized multidimensional information space [6, 7]. Users can experience verisimilar feelings that they will fall in the objective physical world through simulative systems. The technology is currently used in military training, medical science, simulated test, physical training and other sectors. This work aims at improving unsatisfying results of students' physical activities such as low initiative, less time and space. The work applies computer simulation technology, proposes three basic factors and mutual relations in simulative physical activities, and concludes general steps of the application of that technology to activities, laying a foundation of following studies. The work takes bicycle simulated training system as an example and proves that the application of computer simulation technology to modern physical activities can help to get rid of the limitations of space, time and other objective factors. The work indicates that computer simulation technology can improve simulated physical activities according to students' physical qualities before and after taking those activities. However, it needs further studies because the study of the application of simulation technology to simulate physical activities is a new research area limited by technology support, software function, cost and application conditions.

2 Background

Since the computer technology was widely used in the Beijing Olympics in 2008 and the London Olympics in 2012, new compute modes of competitive sports' grades, measuring systems of athletes' physical qualities, and testing systems of exercise physiology indexes have been emerging with a broad future [8, 9]. As computers deal with information with a rapid speed and high accuracy, the computer technology is fit for complex and massive calculations [10], for example, researchers can apply relative information techniques to collect and deal with parameters of athletes as well as store relative data in athletes' physical activities so as to let them understand the gap between their actions and standard actions through simulation systems and help them adapt themselves to physical training conditions and environments better [11, 12]. The computer simulation technology is defined as an applied technology of using computer techniques, mathematical modeling methods and relative applied tools establish a simulated system application model and comprehensively testing existing models under certain experimental conditions. The current computer simulation technology can be divided into three basic types: analog

simulation, digital simulation and hybrid simulation according to concrete types of computer equipment. With the development of modern computer techniques and the improvement of arithmetic speed and ability of computer equipment, the computer simulation technology under the context of the developing digital technology has achieved an overall and substantial replacement of original simulation techniques under traditional models. The new simulation technology can be used in operation and modification in an easy way with high accuracy, rapid speed, reliable result and other features [13]. It improves shortcomings of traditional models such as insufficient space, equipment, time, and teachers, realizes the sharing, and provides feedbacks of problems met in teaching activities; therefore, it achieves individualized teaching "students first" and is good for physical education [14, 15]. Foreign scholars have made massive researches and established human mathematic models promoting the analysis of physical activities. German professor Gawtonski and Polish professor Macukow applied classical analytical dynamics methods and elicited a second-order nonlinear equation. An American professor Kane from Stanford University proposed a series of modeling methods based on the transformation between internal coordinates and external coordinates. American professor Roberson and German professor Wittenburg applied graph theories and established a modeling method entitled tree multi-body system. A South African professor Hazte applied optimal combined synchronous measurements simulating physical activities. Figure 1 shows a soldier training system which can overcome negative training factors caused by fields, equipment and environments through the combination of physical activity analysis and existing study results. It can simulate environments of war fields and take records of and judge soldiers' reactions by computers, which can not only save costs and overcome the negative factors but also realize their normal training with shorter time and higher efficiency.

Fig. 1. Simulation training

3 Methodology

3.1 Computer Simulation Technology

The simulation technology refers to a study method using computer techniques to build a real system model and conduct experiments. It is a comprehensive experimental technology based on system science, system identification, control theory, computing technology and control engineering. When it is applied to physical education, it refers to an

experimental technique subject about the training process reappearing teachers' teaching experience, trainers' training intention, organizers' arranging plan and athletes' training process through the computer simulation technology so as to explain, analyze, forecast, and evaluate sport systems. Key techniques of the simulation technology are mathematic modeling and obtaining sports data. Visual reality and simulation techniques have been playing a more important role providing a broader space for the application of high techs to competitive sports. As the master of nature and human society, the modeling of human beings becomes an important topic as well as a hot subject in human engineering, computer graphics, artificial life and biomechanics studies. The computer simulation technology refers to a method establishing a system model and combining environments (real or simulated) to conduct research, analysis or experiment. It is directly applied to systematic researches as a study method and experiment technique. Figure 2 shows the basic relationship of three elements of computer simulation.

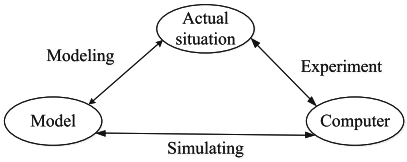

Fig. 2. Three elements of computer simulation

Researchers can use computer simulation system to improve training efficiency, lessen wastes of human resources, material resources, and financial resources caused by statistics. In the meantime, researchers can handle sports data about the physical conditions and the training mechanical analysis of athletes through applying modern computer functions, as well as conclude and analyze relative data in time so as to provide complete training data and plans for athlete's physical training.

Table 1 includes main factors why students have low initiatives towards physical activities whose data are collected through questionnaires. Targeting solving problems such as insufficient time and limited space in physical education, researchers use computer simulation techniques to save training time and space through equipping athletes with certain equipment to collect data, analyzing training parameters every time and formulating training amounts reasonably so that athletes can keep better performance in future trainings. Researchers use the simulation system to collect athletes' motion parameters, compare relative parameters with data of standard actions, and make analysis so as to figure out the weakness of athletes and improve their scores, for example, Fig. 3 applies data from an angle, the center of gravity and speed to analyze basketball trainings. The computer technology can be used to obtain data of athletes from aspects such as endurance, speed, explosive power, and capacity, conduct measurements, formulate scientific and reasonable training projects so as to improve training efficiency. It can also be used to establish training management systems and conducting unified management of athletes' information, skills, and future training plans so as to improve work efficiency.

Table 1. Reasons for absence of sports activities

Factors	Numbers	Ratio %
Time	14	26.4
Site	12	22.6
Money	18	34.0
Interest	9	17.0

Fig. 3. Simulation shooting with computer

3.2 Application Process and Examples

Figure 4 is a flow chart of a computer simulation system including systematic analysis, mathematic modeling, simulated modeling, physical simulation and result analysis as well as feedback. The systematic analysis is the starting point of the study of that system. Through the systematic analysis, researchers can clear and definite the constitution, border, and constraint condition of a system, and determining systematic targets as well as measuring their standards according to problems. Meanwhile, through analyzing solutions of problems, probable costs, and prospective benefits, researchers can extract conceptual models, test those models, and conduct analysis reports. Researchers can confirm systematic variables, describe those variables with mathematical versions according to their mutual relationships and constraint conditions, and confirm parameters. The mathematical modeling is usually built aiming at specific systems. The differential equation and differential equation are generally used in modeling simple systems.

Researchers should pay attention to the complexity of models. If a model is too simple, it cannot completely reflect features of a real system. If a model is too complex, it will lower down simulation efficiency. Therefore, researchers should check the model repeatedly in order to ensure that the model can meet the need of simulation. Researchers establish simulation models based on such a system and put them in the performance of computer simulated real systems. It reflects economic advantages that the whole process does not need excess investments. Researchers comprehensively analyze data from simulation experiments and experimental results, examine the rationality and adequacy of information collected from those experiments, and check whether the information satisfies systematic requirements so as to provide essential data and information of

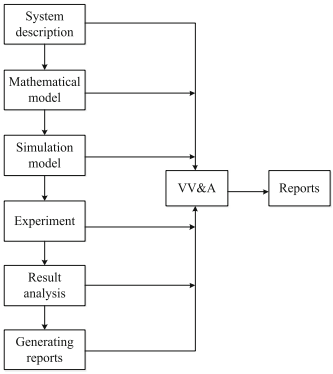

Fig. 4. Flow chart of simulation work

optimize systems. It can provide decision-makers with references by analyzing and arranging simulation results into detailed reports and data relative to systematic practical functions, performances and behavior results.

Table 2 takes records of students' physical activity initiatives. Through further analysis, it can be found that environmental factors can influence students' initiatives. The computer simulation technology can help to create visual, physical training conditions and equipment. In bicycle training, athletes may be influenced by wind, rain, fog and other natural conditions. The bicycle training simulation system can create verisimilar training or competition conditions and weathers through computer simulation techniques. It can use 6 degree of freedom motion (6DOF) platforms to simulate bumpy roads or uphill or downhill motions. Through these techniques, athletes can take a visual training or competitions on simulation trainers. Otherwise, the physical systematic simulation can arrange or reproduce technical motions. The Digital 3D Trampoline Simulating System invented by Wang Zhaoqi and other scholars is a great example. The entity simulation refers to the reproduction of man-made or natural conditions in visual space and time such as exercise physiology and human anatomy. The condition simulation refers to the simulation of study methods relate to achieving certain conditions; for example, the specialized training of athletes' techniques and the proficiency of their motions as well as physiology and biochemistry index changes. The procedure simulation can simulate certain space-time factors so as to create natural and real conditions; for example, the simulation teaching of somersaults in gymnastics and some track and field events (Fig. 5).

Table 2. Enthusiasm of sports

Attitude	Numbers	Ratio %
Join	35	71.4
Not participate	11	22.4
Hate	3	6.2

Fig. 5. Driving simulation system

The computer simulation technology can be used to conduct simulation practices. Unique motion models fit for students' characteristics can be built through visual simulated characters and environments. Through these measures, students can regain initiatives towards sports activities, strengthen their awareness and abilities of exercises so that they can know themselves better and achieve self-improvements.

4 Experimental Analysis and Discussion

These examples prove that the computer simulation technology can be applied in physical activities with great advantages. Researchers transform systematic mathematic models into systematic simulated models through studying physical activities, use computer auxiliary routines to find solutions of mathematic models and relative data, analyze obtained data, check targets under the context of scientific operation procedures, as well as maximally apply data scientific techniques to guide athletes' technique and tactics practices. All those measures greatly improve teaching efficiency and improve students' initiatives in their active procedures.

Table 3 and Fig. 6 indicate that students have made improvements in weightlifting, endurance, standard degree of motions, and long jump compared to conditions before simulative trainings. Through computer simulative trainings, students' physical qualities have significantly improved. The simulation system can simulate the track of standard motions and intuitively show the order and time of each part's movements. It can also target individuals to simulate physical activity conditions through extracting mathematic modeling as well as computer three-dimensional technique, and make comparisons and analysis so as to change or correct students' motions.

Table 3. Physical detect before and after the application of computer simulation technology

Items	Before	After
Weightlifting (times)	31	42
1000 m (S)	212	208
Long jumping	2.01	2.12

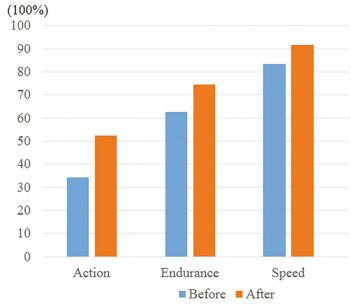

Fig. 6. The compliance rates before and after using the computer simulation technology

The application of simulation systems can benefit technology learning; for example, high reality degrees and beautiful frames will raise students' interests towards learning so as to achieve good results. It can also improve athlete's technique and tactical adaptation towards competitors, simulate audiences' attitudes, and simulate competition conditions and atmosphere so as to make athlete devote their minds to the competition. It can strengthen athletes' psychological endurance through mental aptitude trainings so that athletes can overcome their mental blocks and calmly face adverse impacts caused by environmental changes.

5 Conclusion

The science and technology-oriented sports, accompanied by artificial feedbacks, will lead the development of future sports. In the meanwhile, with the development of computer technology, future sports will realize automation and informatization; for example, the office automation of sports management can be achieved through information management systems, and the collection and arrangement of data can be achieved through simulation systems so that the information will be more open, just, and fair and the sports environments will be more healthy. It can be realized that trainers can analyze and conclude athletes' data after competitions and trainings as well as formulate feasible training plans. Through computer multimedia treatment techniques, the decomposition process and scientific analysis of a competition can be realized so that athletes can find their competitors' technical errors to win the game. In the meantime, research results can improve students' thinking and doing abilities as well as their initiatives and problems in rehabilitation trainings and mental trainings. Therefore, computer technology is a comprehensive subject with a broad future. However, it needs further studies because the study of the application of simulation technology to simulate physical activities is a new research area limited by conditions such as technology support, software function, cost and application.

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Research on Data Storage Algorithm Based on Metallurgy Control System

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Abstract. In the traditional method, the data structure of the embedded system is optimized by using K-L method. With the increase of the high load of the metallurgical control data, the cost of data storage is high, and the metallurgical control performance is not good. In order to improve control property and storage property of an embedded metallurgy system, this paper raises a kind of data structure optimum storage algorithm based on an embedded metallurgy system of optimum basic function adaptive matching on metallurgy control system data storage. It's proved by the stimulation outcome that it efficiently reduces data storage expense and enlarges data storage space by using method raised in this paper, which further improves control ability and storage ability of data interaction in the embedded metallurgy system.

Keywords: Embedded system · Metallurgy control · Data storage

1 Introduction

With the rapid development of metallurgy industry, metallurgy control has been the base to improve metallurgy system productivity and control precision in embedded system. It can improve the storage power of metallurgy data by using computer control technology to interact and transmit metallurgy control informative data, which distributes control data into the storage system through embedded data storage. Storage property of a metallurgical control data structure has an influence on metallurgy and regulation capacity, however storage property isn't pretty good because of irregularity of memory byte and distribution complexity of data structure. This paper raised a kind of data structure optimum storage algorithm based on an embedded metallurgy system of optimum basic function adaptive matching in the metallurgy control system, then extracts the characteristics of stored data and establishes an information model. Based on this data storage property is improved by using optimum basic function adaptive matching to match adaptability. Stimulation experiment aims to have a property test, which educes efficient conclusion through showing superior performance in optimizing the storage data structure of metallurgy system and improving data storage property [1, 2].

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The data structure of the embedded system in metallurgical analysis, optimization of data storage algorithm of a metallurgical control system, improve the metallurgical system control performance and the performance of the traditional method, the metallurgical control grid space uneven distribution of serious problems. In this regard, the related literature was improved, the literature proposed a feature extraction and storage optimization design method of large metallurgical harmonic oscillation control data based on the realization of embedded storage and scheduling of metallurgical control data, but the algorithm of complex structure and computational overhead is relatively large; some scholars put forward the optimization storage design of data structure based on adaptive block matching embedded metallurgy system, easily lead to under the strong interference environment storage system generated data redundancy, lead to control performance of metallurgical data is not good, the storage overhead is relatively large, and the robustness is not good [3]. In view of the above problems, this paper puts forward an improved design of the algorithm, which is based on the optimal basis function, which is based on the adaptive matching of embedded metallurgical system. The overall construction of storage model and data structure analysis of embedded metallurgical system is carried out.

The storage model of metallurgical control information data structure is a data resource scheduling through multiple service nodes, embedded in the metallurgy system, users are I/O by the entity resource model, USB and disk layer three layer model of distribution. Firstly, the data storage mechanism of metallurgical control information in the embedded metallurgy system is analyzed [4]. The metallurgical control information database distribution will be a large number of data to multiple service nodes, metallurgical control information database for multi-source information resources distributed control based on cloud computing application layer processor, embedded system under the control of metallurgical information data storage and management (See Fig. 1).

Fig. 1. The metallurgical automation field.

2 Problem Discussion and General Storage Model Establishment of Metallurgy System

2.1 Background Information and Problem Discussion

In traditional method, it is serious that algorithm grid apace doesn't distribute equally in metallurgy control by analyzing data structures of the embedded metallurgy system, optimizing data storage algorithm of the metallurgy control system and improving control property and huff-puff property of a metallurgy system [5]. So, some related bibliography raises new method to improve it. For instance, based on bibliographic raises a kind of characteristics extraction and optimum storage design of huge metallurgy control data, which realizes embedded storage and scheduling to metallurgy control data, but the structural hierarchy of this kind of algorithm is complex, and algorithm cost is too high. As a result, control property of metallurgy data and algorithm robustness is not pretty good, and coat of storage takes too much [6].

Non-ferrous metals in the narrow sense, also known as non ferrous metals, are iron, fierce, outside the network of all metal. General non-ferrous metals also include nonferrous alloys. That an alloy consisting of one or more other elements, as a base (usually more than 50%) [7]. Non-ferrous metals are divided into non-ferrous metals, non-ferrous metals, and precious metals and rare metals four categories. Rare metals that including rare metal and rare refractory metals, rare metals, rare earth metals and rare metals [8].

Due to the excellent properties of high purity materials in physics, mechanics and so on, the purity of the products of heavy metals have gradually developed in the direction of high purity. Light metal alloy has superior performance, can form a variety of many other metals, its excellent performance, such as the alloy easy forming, good thermal conductivity, low price, is widely used in aerospace, transportation, communications, electronics, light industry, building materials and other industries. Magnesium alloy has the advantages of high specific strength, mach inability, damping, electromagnetic shielding ability, good thermal conductivity, etc., and its application in the field of electronics, aerospace, transportation and communication is widely used in the field of electronic, aerospace, communications and communications [9]. China's rare metal industry was established in the early 1960s to meet the needs of the military industry. After decades of efforts, now has formed a relatively complete industrial system, mainly the production of rare metal has reached a certain scale, but because there is a certain gap between enterprises, the level of technology and equipment of metal recovery, consumption and quality with the world advanced level, so in the development of a certain extent hindered the domestic market.

As for this problem, this paper improves algorithm design, raises a kind of data structure optimum storage algorithm based on an embedded metallurgy system of optimum basic function adaptive matching on metallurgy control system data storage [10], and analyzes data structure and generally establishes storage models of embedded metallurgy system (See Fig. 2).

Fig. 2. Embedded metallurgical system accessories.

2.2 General Establishment and Data Structure Analysis of Storage Model in Embedded Metallurgy System

Through multiple-mode data source storage model of metallurgy control mode of metallurgy control informative data structure is an I/O, USB and magnetic disk, that is, three-layer distribution model used by a user node in the embedded metallurgy system. First, it needs to analyze metallurgy control informative data storage mechanism in embedded metallurgy system [11]. Distributing mass data into multiple service nodes, metallurgy control informative database processes multiple source informative distribution control to store and manage metallurgy control informative data in the embedded metallurgy system according to processor in cloud computing application layers.

With the development and wide application of computer technology, the development and application of database have been deep into every field [12]. At present, the database mainly related to metallurgy is mainly concentrated in the field of chemical engineering, metallurgy and metallurgical thermodynamic calculation. After years of development, the thermodynamic database has been developed. But because of the limitation of objective conditions, these databases exist many problems: such as the transplantation of the software, the database capacity is small, the query hit rate and recall rate are low; can carry out Internet query, the lack of mineralogy, smelting process and technical parameters and technical indexes of the data, only compound thermodynamic calculations. From a number of already established at present has the support of scientific research and the ability to put the scientific database, the database system architecture adopts single or Client/Server structure system, the resource sharing rate is low, is not conducive to the promotion and use of. In recent years, with the continuous development of internet technology, browser/Web server structure model (that is, B/S structure model) as a kind of change or improvement of C/S structure has been widely used. In this structure, the user interface is implemented by WWW browser, business logic on the server (Hou Duan), in the aspect of application development, software configuration and transplantation is C/S has a great advantage, and, with the help of the Internet, can be convenient to realize resource sharing [13]. However, the metallurgical property database not only needs information, but also involves a lot of mathematical calculations and graphics display. Based on the browser/Web server structure model, as a result of the client, the client cannot afford to calculate the task, the server load. If the server load balancing problem cannot be solved, the system performance will be greatly affected [14]. Nonferrous metal database with mineralogical database, thermodynamic database and smelting process database, metallurgical principle database, metallurgical solution (containing molten salt, and slag, matte, soluble) database metallurgical process simulation and optimization of multiple sub databases. A system with a large amount of numerical computation, graphics display complex characteristics. Simple browser/Web server structure model, both in performance and icon cannot meet the requirements of the system [15].

Assuming X and Y to be a unit vector attributes sets of metallurgy control information in the mechanism of metallurgy control informative data storage in an embedded metallurgy system, such as $X \Rightarrow Y$, which is a kind of association rules between basic function and control data. Adding momentum inertial coefficient in embedded

metallurgy control informative data. Complex attributes integration of metallurgy control informative data can be gained. G can stand for embedded metallurgy control informative data structure, namely G = (V E W C).

3 Design for Algorithm Improvement

Based on storage model built in Sect. 2.2 it needs to design optimum data storage, optimize data storage algorithm in the metallurgy control system, improve control attributes and huff- puff attributes of metallurgy system, and raises a kind of data structure optimum storage algorithm relied on an embedded metallurgy system of optimum basic function adaptive matching in metallurgy control system data storage. First, it needs to build a data structure of the embedded metallurgy system which is a vector space composed of the value of the VI. Time series of data stream in the embedded metallurgy system is {x (t0 + iΔt)}, i = 0, 1, …, N−1. Through decentralized control reconstruct characteristic space of time series in metallurgy control informative data, {x (t0 + iΔt)}, i = 0, 1, …, N −1 can be gained. Among them the vector length of control informative data in metallurgy system is N. By sampling vector expression of metallurgy control informative data storage stage in the embedded metallurgy system is

$$X = J^m\left[x(\mathrm{t}), \mathrm{x}(\mathrm{t}_0 + \Delta\ \mathrm{t}), \ldots, x\ \left(t_0 + (\mathrm{k} - 1)\Delta\ \mathrm{t}\right)\right] \tag{1}$$

Among them, x(t) stands for informative stream time series of metallurgy control informative data storage system I n embedded metallurgy system; J stands for space; m stands for embedding dimension. As for cloud storage system, data of task are produced by vector from I value, and it can reduce the dimension for redundant signal data, which contributes to offering data block to the block uploaded by a client. Realizing cloud storage and adaptive matching pyramidal decomposition of metallurgy control information data can be gained. Xp(u) is spectrum characteristic of the separable sample in metallurgy control informative data. The primary characteristic of low-loaded storage of metallurgy control informative data is

$$X_P(u) = s_c(t)e^{j2\pi f_0 t} = \frac{1}{\sqrt{T}} rect\left(\frac{t}{T}\right)e^{j2\pi(f_0 t + Kt^2)/2} \tag{2}$$

Among them, Sc(t) stands for scalar time series of metallurgy control information; $e^{j2\pi f_0 t}$ stands for distribution state character of storage space; f0 is main characteristic frequency. T stands for data huff-puff quantity of storage space. Based on adaptive matching pyramidal decomposition time-window recombining and separating of metallurgy control informative data integration vector matrix of dynamic data storage is as follows:

$$R_i(k) = diag\left\{r_{(i-1)q+1}(k), \mathrm{r}_{(i-1)q+2}(k), \ldots, r_{(i-1)q+q}(k)\right\} \tag{3}$$

Among them, I = 1, 2, …, N stands in memory of metallurgy control informative data storage. According to different types of data storage area, using a data filter in information stream length of infinite dimensional metallurgy control informative data.

4 Stimulation Experiment and Outcome Analysis

In order to test the property of data structure optimum storage in realizing embedded metallurgy system, which is mentioned in this paper, stimulation experiment is carried out. Using Matlab to have an algorithm stimulation and establish embedded metallurgy system in metallurgy control it needs to store metallurgy control informative data and schedule task in the embedded metallurgy system. Time internal of data sample is 0. 1 s, and data execution dead time is 2400 Mbps. Sample frequency of cloud storage node in metallurgy control informative data is $f_s = 4f_0 = 20$ kHz. Central time of metallurgy control in embedded metallurgy system is t0 = 15 s. Data length is 8000. According to stimulation environment and parameter setting mentioned above, it can gain the wave forms in time domain of metallurgy control informative data through optimizing data, and sampling data. The input SNR = −6 dB as interference condition.

The spatial distribution character of metallurgy control information's storage state using method raised in this paper to have a data sampling. Time-sampling data us accurate. Based on this sample data set it can optimize and integrate data structure distribution, which aims to realize data storage optimization. In order to compare algorithm property, method varied in this paper along with traditional method contributes to gaining state distribution characteristic of data storage. Algorithm raised in this paper takes much advantage over designing optimum data storage. It owns better peak- feature clustering features, and its anti-interference property in data storage is powerful, which effectively enlarge the space of data storage and decrease the load of data storage as well as save 45.66% storage expense.

5 Conclusion

This paper proposed a kind of data structure optimum storage algorithm for concretely studying data algorithm based on an embedded metallurgy system of optimum basic function adaptive matching on metallurgy control system data storage, and concretely expounded analysis, modeling and optimization of data storage structure according to structural characteristics of embedded system and utilization of hardware-assisted virtualization technology.

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Fault Diagnosis Algorithm for Wireless Sensor-Based on Fault Tolerant Topology

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Abstract. Based on the principle that the wireless sensors in a wireless network can relocate its loads to adjacent nodes when there are single node failures, this thesis proposed a load redistribution model in fault and analyses chain fault diagnosis algorithm of adjacent nodes in order to study the relationships between the scale of parameters and the cascading failure in the sensor network load. By the simulation test, it showed that this algorithm can effectively reduce the chain load effect caused by overload which works well in the wireless network. The problem of cascading failures caused by the random node failure, in order to reduce cascading failures caused by the wireless sensor network as much as possible damage to the chain fault diagnosis algorithm is proposed for wireless sensor network scale-free fault-tolerant topology. The algorithm is based on a single node failure load is redistributed to adjacent nodes, a cascading failure under the load redistribution model, cascading failure scale arising from analysis of the single node failures. The relationship between the parameters of load chain fault diagnosis algorithm using the neighboring nodes to the sensor network research and cascading failure scale, node loss as much as possible to reduce cascading failures caused. The simulation results show that the algorithm is effective inhibited by over load chain loading effect caused by the great, played a good effect in reducing network losses. It is a sharp increase in recent years, the number of users and applications, some of the nodes in the Internet in the high load working condition. If these nodes attack, such as virus attacks will lead to the overload even cannot work normally, forcing data packets to the other routers routing, which can cause overload successively, produce cascading failure (cascading failures), large-scale cascading failure occurs, often with strong destruction.

Keywords: Wireless network sensors · Fault tolerant topology · Cascading failure

1 Introduction

The study of network robustness to node failures has always been concerned by many scholars. When the load is introduced, the node may lead of a further failure if the load to nodes exceeds its capacity [1]. The entire network can be greatly affected by the cascading failure. For cascading failures, in fact, is a kind of relative fault whose fault

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principles cannot be understood. Therefore, the kind of fault is a kind of cascading failures that are hard to solve in the internet. Considering cascading failures brought about by node failures, the cascading failure of scale-free topology is deduced by some scholars. Besides, by adopting the branch processing method, the scholars also conducted analyses for cascading failure of power-law size of on the key ability. Wireless sensor is widely used in life. Wireless sensor technology has been improved, more attention, but also to bring a lot of convenience to our lives.

Fault tolerant Ethernet (FTE) is the control network of PKS FTE. The experience not only provides the characteristics of fault tolerance, but also provides the application of fast network, and the safety of industrial Ethernet control applications. Fault tolerant Ethernet (FTE) is a single network (logic) of redundant network structure (physical), which is realized by the FTE Honeywell driver and commercial network device. Backbone network be used in PKS Experian. Computer network topology is referring to the network each site in the form of mutual connection. In the local area network is clear that the file server, workstations and cables, and so on. Now the most important topologies are bus topology, star topology, ring topology, tree topology (evolved from the bus type) as well as their mixed type. As the name implies, the bus is the file server and workstations are connected with a cable called public bus, and the bus ends must have finalizes; it is the star topology with a device as a central connection point, each workstation with it directly connected to form a star; and the ring topology is that all sites of each other a serial connection, like as the chain to form a circular loop; the three basic topology is mixed up by natural hybrid. The topological structure of the computer network is the method research and reference topology is independent of the size and shape of the points and lines. The computer network and communication equipment is abstracted as a point, the transmission medium is abstracted as a line topology composed of point and line geometry is the computer network. The process of network evolution, from the growth of large network local area network evolution often takes a long time, and there will be some confusion. With the expanding of the network, and sometimes also need to plan for growth, such as to improve the fault tolerance of the network in the main part of the link to the ring, but this does not affect the overall characteristics of the fractal in the process of Internet. Therefore, the cascading failure, need to consider the impact of fractal characteristics on the network topology. Restricted by the harsh deployment environment and limited energy resources, wireless sensor networks facing environmental damage and energy depletion comprehensive node failure threat from network topology node failure prone to disconnection and empty, resulting in reduced network connectivity and coverage quality, which makes the part (or all) network monitoring information cannot be passed to the destination node, causes the network cannot continue in node failure under the protection of the application function. Therefore, wireless sensor network fault tolerant topology is the most fundamental basis for the practical application of wireless sensor networks, and it is also an important research content in the field of wireless sensor network security.

2 Load Redistribution for Cascading Failures

While working with the scale of a cascading failure of cascading failures in wireless sensor networks, it can be found that the balance of the load can be changed and the load of other nodes will be redistributed for the failure of a single random node. If the fixed capacity of these nodes is sufficient enough to handle the additional load, the load will be redistributed and cascading failures will be caused, which may result in a substantial decline in the performance of the network topology. Therefore, according to the variable load of wireless sensor networks and the inherent performance of scale-free topology, a load redistribution model in the case of random node failure is proposed. Then, a node's initial load capacity allocation and load redistribution rule is introduced. In the scale-free topology of wireless sensor networks, in each time step it can be assumed as a packet data in each node exchange between ordered pairs, and then the total data packet through the node is a node load [2]. The increasing complexity of software directly has led to the increasing complexity of software failure. From the point of view of system science, the cascading failure characteristics of complex software in the overall use of complex network methods and techniques is a new perspective of the research of software quality. To function as a node, in order to adjust the relations as edges, proposed the use of directed edges and the right side of the topology model representation function call and closeness degree. The cascading failure model is established by introducing the function of complex software fault

Fig. 1. Wireless sensor in our life.

tolerance and fault strength software, fault propagation behavior simulation software run time on three actual software networks. The experimental results show that the fault strength, weak fault initial node and less high fault tolerance will slow down the fault propagation speed and reduce the fault scope. Analysis of reasons for some software nodes eventually not be infected. This model helps It provide a new way of thinking for software engineers to accurately detect the complexity and fault tolerance of the complex software. According to the reality of the network load redistribution rule is often between global distribution and nearest neighbor distribution, uniform distribution and extreme characteristics of no uniform distribution, presents a complex network cascade adjust load distribution and load redistribution. The heterogeneity of the failure model and analyzes the model cascade in the scale-free networks. The failure condition. Simulation and **analytical** results show that the reasonable adjustment of invulnerability load range, the redistribution of load distribution heterogeneity can significantly improve the complex network against cascading failure. The following Fig. 1 is an unlimited number of sensors in the life of some of the features, and scholars for the study of this technology.

3 Chain Fault Diagnosis Algorithm for Adjacent Nodes

In the network topology, node is the interconnection network of any public branch terminal or network in two or more branches. A network node is a computer or other device connected to a network with an independent address and with the function of transmitting or receiving data. The node may be a workstation, a client, a network user, or a personal computer, and can also be a device for a server, a printer, and other network connections. Each workstation, server, terminal equipment, network equipment, that has its own unique network address of the device is a network node. The whole network is composed of a lot of network nodes, the number of network nodes connected with the communication lines, the formation of a certain geometric relationship, which is the computer network topology. Multi computer system provides a powerful tool for the realization of high performance computing. Large capacity distributed information storage and transmission, and the extensive use of multi machine system has become an important symbol of the modern information society. With the increasing scale of the system, the possibility of failure in the system will increase. Therefore, how to maintain the high reliability and availability of the system becomes an urgent problem to be solved. A major means to improve the reliability of the system is to detect system node and communication link failures, to facilitate maintenance personnel to repair the faulty part as soon as possible to restore normal operating state of the system. Because the value of the load parameter is determined by the scale of chain fault of scale-free topology, the relationships between the load parameter λ and the scale index H in the scale free topology of wireless sensor network will be discussed in this part [3]. Based on the threshold of the maximum scale parameter, HTh, the critical threshold λ th that triggers large-scale cascading failure can be found, which is conducive to the prevention of cascading failure.

Suppose a fault distribution is:

$$\omega(\psi) = \frac{\alpha\psi}{\lg \beta}, \alpha > 0, \beta > 0 \tag{1}$$

The fault distribution function of the node can be expressed as:

$$G(z) = \sum_{\psi_{\min}}^{\psi_{\max}} \omega(\psi) \exp(z) \tag{2}$$

ψ min represents the minimum load level, and ψ max represents the maximum load level. It can be assumed that the load randomly selects a link and reaches a load level along the link, ψ. Besides, using P(ψ) represents the failure probability of the node.

The size of the remaining network can be evaluated by the residual degree of the nodes that are connected to the random link. When the remaining degree of the node that is connected to the random link is 0, the size of the remaining network is 1. When the remaining degree of the node connected to the random link is larger than or equals 1, the size of the remaining network is a size of 1 plus the size of the connection node. Similarly, at the end of the cascading failure, the size of the remaining network of the faulty distribution function can be attained [4].

Through above analysis, after cascading failures triggered by single random failure nodes, the size of the residual network can act as a term to assess the fault degree of neighboring nodes, namely scale exponent H of cascading failures, which can be expressed as:

$$H = \frac{1}{S(z)} \tag{3}$$

The cascading failure of scale-free topology in a wireless sensor network is caused by a random failure node. After the cascading failure is finished, the scale index H can be obtained. So, we can obtain the relative expression for the load parameter λ and the scale index H of the scale free topology of the wireless sensor network.

As for the threshold value of the maximum scale parameter HTh occurring in the case of only one fault node:

$$H = \rho \frac{n-1}{n} \tag{4}$$

By this equation, the critical threshold value λ Th that triggers large-scale cascading failure can be obtained.

According to the initial load Formula $L_i = \psi_i^{\lambda}$ of node Vi, in a context that the node Vi's load grade is certainty, by choosing a appropriate parameter λ to make $\lambda < \lambda$ th so that we can ensure that a large-scale cascading failure won't occurred in neighboring nodes even a node is failure.

4 Experimental Simulation Results

In this paper, considering the energy depletion and environmental damage comprehensive node failure factors, the establishment of integrated fault node model, and using inequality method and extremum of function analysis, influence of node degree on topological characteristic parameters of the comprehensive fault tolerance, that can meet the network lifetime and integrated fault tolerance capability requirements of optimal node degree then, the formation of a redundant fault-tolerant topology control algorithm to realize the optimization of life cycle and integrated fault tolerant. Aiming at the shortage of the redundant fault-tolerant topology cannot cope with multi node failure, the effectiveness of network connectivity and coverage of the proposed topology fault tolerance and fault tolerance measure, to measure the degree distribution, characteristic parameters of topology probability generating function method of the comprehensive fault tolerance of the influence of the best distribution degree of node failure are presented a long time to maintain network connectivity and coverage of topology. Based on the optimal degree distribution, to prolong the network lifetime and reduce network interference for the common optimization goal to establish scale-free fault-tolerant topology model, by solving the life interference scale-free degree distribution of Fault Tolerant Topology expression, form a kind of life balance interference scale-free Fault Tolerant Topology control algorithm, ensure performance extension the life period and reduce the interference in the more comprehensive strong fault tolerant node failure. For scale-free fault-tolerant topology prone to cascading failure problems, the establishment of a variable load and fixed capacity cascading failure model, through the research on the influence of Fault Tolerant Topology without standard load change on the fault tolerance of the cascade, due to a single random node failure caused no standard critical load value of large-scale cascading failure fault tolerant topology is derived. From the point of view of optimizing the parameters to avoid cascading single node failure under random scale-free Fault Tolerant Topology failure hazard. In order to validate the critical load parameter λ, we performed the corresponding simulation analysis. The first thing is to consider the relationships between scale exponent H and the load parameters λ in wireless sensor network. We can set the network size as follows: let a network node be n = 100 and fault distribution be $\omega(\psi) = 1.56\psi^{-1.45}$. And then set three node capacity respectively Q0 = 17, 20, 25.

The load factors of the nodes are unified as $\varepsilon = 1, p = 1$ and the range of load parameter λ varied in between (−4, 4). Under the circumstances, we conducted a simulation programming algorithm by Matlab7.0 software.

Figure 2 shows that the change of the scale index of H with the change of load parameters λ. It be seen from the figure that the increasing scale index H make the load parameters turn small. This is because the greater the initial parameter λ, the load of a node is bigger. When $\lambda > \lambda$ Th, as long as there is a node failure, it will lead to cascading failures of neighbor nodes, resulting in an increasing number of nodes fails and the less number of remaining network nodes after the failures.

The greater the node capacity Q0 is, the larger the scale index H is. The greater Q0 indicates the greater load value that the node can bear. Besides, the chain fault conditions caused by overload can be suppressed effectively. For cascaded wireless sensor

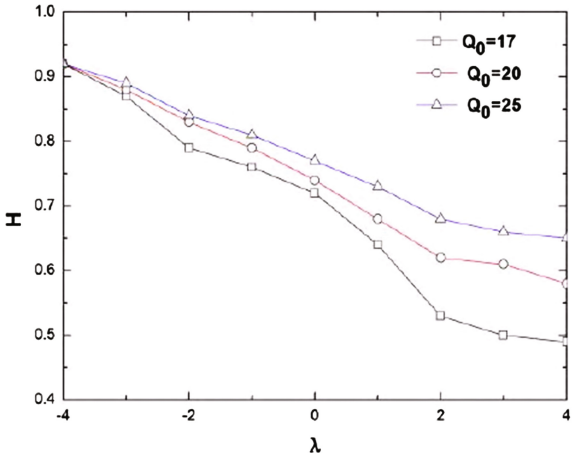

Fig. 2. One -The scale index H under load parameter λ.

networks scale-free fault-tolerant topology failure problem, firstly the generating function method, cascade derived single random node failures in wireless sensor network, scale-free fault-tolerant topology failure scale, then the load distribution condition in power function, to calculate the critical load value of non-standard Fault Tolerant Topology cascading failure trigger the wireless sensor network. The results show that the scale-free fault-tolerant topology in wireless sensor networks, when the network load parameter exceeds the critical value, a random node failure will cause the entire network cascading failure. Simulation results verify the correctness of the analytical derivation.

5 Conclusion

With growing expansion for wireless sensor network applications of the scale-free topology, network node failure problem is drawing even more attention. In order to minimize network node loss caused by random node failures as far as possible, the chain fault diagnosis algorithm of proposed a wireless sensor network scale-free fault tolerant topology is proposed in this thesis. Considering the load redistribution under single random node failures, this thesis adopts the load distribution model of cascading failures to analyze the load redistribution and uses chain fault diagnosis algorithm of adjacent nodes to control the load parameters. All these are conducive to take defensive measures against cascading failures. Besides, the simulation results show that the comparison algorithm is secondary to the algorithm on reducing the failure losses of network nodes. In view of the problem that the failure of the sensor network is not connected with the sensor network, the Fault Tolerant Topology Control Algorithm of wireless sensor network is proposed, which is based on the problem that the topology optimization cannot maintain the normal operation of the network. In this paper, by adjusting the transmission power of sensor nodes, the topology of the network is

switched based on the optimal rigid graph, and the network connectivity is restored. Simulation results show that the proposed algorithm not only has good fault tolerance, but also reduces the complexity of the connectivity recovery process and reduces the energy loss. In view of the limited transmission power range of sensor nodes, the problem of limited fault tolerance ability in practical applications is introduced, which can be used to restore the connectivity of the network by the mobile sensor nodes. A fault tolerant topology control algorithm for dynamic sensor networks based on connectivity restoration is proposed in this paper. Determine the key nodes through the influence of communication nodes on the nodes, and whether it is able to communicate with the nodes to determine the node fault, according to the node selection evaluation function Best Candidate (BC) instead of node fault node, network connectivity recovery. The algorithm avoids the emergence of the cascade motion, simplifies the implementation process of the connectivity recovery and reduces the consumption of energy.

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Improvements of Wireless Network Routing Clustering Algorithm

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Abstract. According to the agreement of wireless network base layer, and for the issues of energy consumption in the network search and node inequality, this paper introduced routing clustering algorithm, which is improved by the acoustic search algorithm, to make parameter optimization settings with nodes, node distance and cluster distance and decrease routing nodes allocation time so as to reduce the network search time, saves the transmission energy consumption and increase operational efficiency. Experiments proved the feasibility of optimization algorithm proposed in this paper, which has realized the practical application effect on the rational optimization of routing clustering. According to the LEACH protocol cluster random, the cluster head distribution is uniform, resulting in the network life cycle is too short, put forward a hierarchical clustering routing algorithm based on wireless sensor (Multi-Energy balance clustering hierarchy, MEBC). In the algorithm, the sensor nodes are divided into different levels, in order to hop and energy as the transmission path the establishment of standards, through the autonomy of base station and the multi hop transmission to route choice, rather than direct transmission of multi cluster head sensor node and the base station node, it can effectively prolong the network life cycle.

Keywords: Wireless network · Clustering algorithm · Acoustic algorithm

1 Introduction

Wireless sensor network integrates information acquisition, processing and transport, which have a very extensive application scenario in areas such as environmental monitoring, biomedical and disaster emergency. As it often deploys periodic surveillance missions in hostile environments, energy problem has become an important problem restricting its development and application. Designing an efficient routing protocol performance has become the focus and difficulty in sensor network research in the limited node energy conditions [1]. As the first type of hierarchical routing protocol, LEACH protocol, compared with the traditional planar routing protocol, has a large network throughput and low energy consumption of MAC layer protocols. Due to its local control technology of the data transmission, it will meet the demand for a wide range of real-time collection, transmission, analysis and data processing. But the

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algorithm exists some shortcomings, such as not considering the residual energy of nodes and uneven distribution of cluster head nodes during the selection period of cluster nodes. As for the above clustering algorithm research, the choice for cluster head nodes only considers an indicator as a deciding factor, making the whole system performance meet bottlenecks, and eventually reducing the optimization effect greatly [2]. Based on this aspect, this article transforms the problem for selection of cluster head nodes into a multi-objective optimization problem with the optimal object of distance between nodes and Sink node, clustering distance and system energy consumption. For multi-objective optimization, this paper proposes a parameter adaptive binary system and acoustic search optimization algorithm. The experimental results show that the proposed algorithm can reduce the system energy consumption and prolong network life [3].

Wireless sensor networks are composed of a large number of micro sensor nodes deployed in the monitoring area, which form a multi hop and self-organized network system. In wireless sensor network architecture, the network layer is responsible for the discovery and maintenance of routing. The routing protocol of network layer has an important influence on the quality of wireless sensor networks. Wireless sensor network routing protocol in accordance with the final formation of the topology, can be divided into planar routing protocol and cluster routing protocol. In the plane routing protocol, the status of all nodes is equal, there is no bottleneck problem in principle. The disadvantage is that the scalability is poor, and the maintenance of the dynamic changes of the route requires a lot of control information. In the cluster-based routing protocol, cluster member function is relatively simple, do not need to maintain routing information complex, which greatly reduces the amount of routing information control, has good scalability; its disadvantage is that the cluster head nodes may become the bottleneck of the network. So it is very important to realize the energy balance of the whole network in the cluster routing protocol. In the study of wireless sensor networks, sensor nodes are limited due to their own conditions, the focus remains on the energy constraint, the current research in wireless sensor network is mainly concentrated in the link layer and the network layer. Network data transmission cannot be separated from the routing protocol, routing protocol is the basis of the wireless sensor network, but also the core of the network layer. For the traditional wireless network, because there is no energy constraint, the routing protocol cannot consider the energy restriction and will focus on finding the optimal path between nodes, the route optimization and resource management strategies to maximize the bandwidth utilization rate, at the same time, load balancing and congestion control [4]. So the traditional routing protocols are not appropriate for wireless sensor networks. Therefore, it is necessary to design a new routing protocol to meet the demand of the energy of the sensor nodes. Wireless sensor network is a hot research field in the world, which has attracted much attention. It combines sensor technology, embedded computer technology, modern network and wireless communication technology, distributed information processing technology, through various integrated micro sensor wireless sensor network real-time monitoring, sensing and collecting all kinds of environmental or monitoring information, the information is sent by wireless mode, and form a multi hop network mode sent to the user terminal, so as to realize the communication of physical world, computer world and human society, the world's three yuan. Sensor networks have very broad application prospects.

2 Multi-objective Optimization of WSN Routing

2.1 Network Model

The network model of wireless sensor networks mainly refers to its topology structure. There are many topological structures of the sensor, which is isomorphic and heterogeneous, and it is divided into many types of topological structure according to the cluster heads and routing nodes in heterogeneous networks. The energy model mainly refers to the communication energy model, namely the infinite sensor in each collected information sent to the cluster head, and then through the cluster head to the base station through the routing process, the information sending, receiving, communication space, energy consumption in the process of forwarding. N nodes are deployed in a two-dimensional plane square M × M monitoring area. All nodes are homogeneous and does not have the ability to move, and Sink nodes in the monitoring area outside are in a fixed position. The position information of nodes can be obtained by GPS or positioning technology. Wireless sensor structure is a large number of sensor nodes randomly deployed in the monitoring area or nearby, in order to form a self-organizing network. The data collected by the sensor nodes are transferred from the adjacent sensor nodes to the sink by hop by hop by hop. At last, the data is sent to the external network through the protocol conversion, and the data are transmitted to the management station via the Internet or satellite. At the same time, users can configure and manage the sensor network by the management station (See Fig. 1).

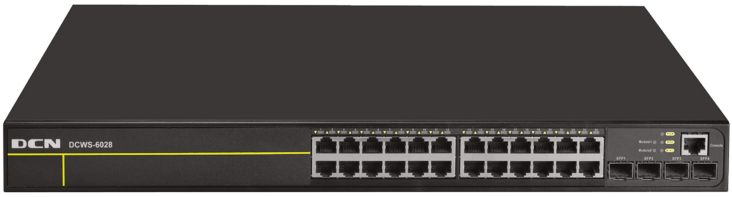

Fig. 1. Intelligent wireless controller EAC620

2.2 Multi-objective Model

The distance DS between objective function f1 and the Sink node has its mathematical expression,

$$DS = \sum_{k=1}^{b} d_{ksink} \tag{1}$$

The b represents the total deployment number of nodes, and dksink represents the Euclidean distance between k nodes and the Sink node. The Cluster distance CD of objective Function f2 can be defined as,

$$CD = \sum_{t=1}^{w} d_t = \sum_{t=1}^{w} \left(\sum_{i=1}^{a} d_{ih} + d_{h\text{sink}} \right) \tag{2}$$

where, dt represents the distance of cluster t, W represents the total number of node clusters and dih represents the Euclidean distance between node i and node h. Among these, a represents the number of member nodes with cluster head h, and dhsink represents the Euclidean distance node h and node Sink. The network energy consumption E of objective function f3 has its mathematical expression,

$$R = \sum_{i=1}^{w} \left(\sum_{j=1}^{a} R_{T_{jh}} + aR_e + R_{T_{h\text{sink}}} \right) \tag{3}$$

For each cluster, $\sum_{j=1}^{a} R_{T_{jh}}$ represents the energy power consumed by a member nodes, which aim to transmit data to the cluster head nodes, a R_e represents the cluster head node receives the energy which is consumed by transmitted data of a member nodes, $R_{T_{h\text{sink}}}$ represents the consumption of energy when the cluster head node transmits data to the sink nodes. The harmony search optimization algorithm will be used to solve the multi-objective optimization problems proposed in this paper.

3 Algorithm Description

Clustering analysis, also called group analysis, which is a statistical analysis method of the research (sample or index) classification problem, is also an important algorithm of data mining. Clustering (Cluster) analysis is composed of a number of patterns (Pattern), usually, the pattern is a metric (Measurement) of the vector, or is a point in the multi-dimensional space. Clustering analysis is based on similarity, and has more similarities between patterns in a cluster than in the same cluster. Cluster analysis is originated from the taxonomy. In ancient taxonomy, people mainly rely on experience and professional knowledge to achieve classification, and rarely use mathematical tools for quantitative classification. With the development of science and technology, the classification of the increasingly high demand, that sometimes only by experience and professional knowledge is difficult to accurately classify, people gradually put mathematical tools referenced in the taxonomy, the formation of numerical taxonomy, and then the multivariate analysis technology into numerical taxonomy and form cluster analysis. Clustering analysis is very rich in content, there are systematic clustering method, ordered a sample clustering (See Fig. 2), dynamic clustering, fuzzy clustering method, graph theory clustering method, clustering forecast method, etc.

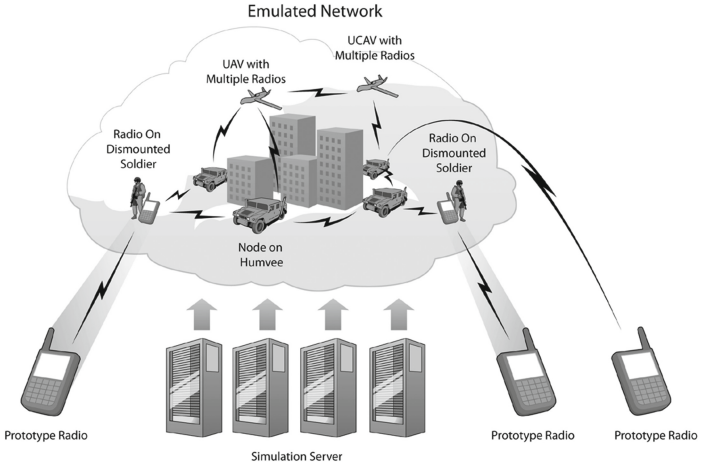

Fig. 2. Ultra real time large-scale C4ISTAR system

Harmony search algorithm, HS, is a kind of heuristic intelligent optimization algorithm, which has the advantages of fast convergence and simple implementation. What's more, it has been successfully applied to many combinatorial optimization problems. Optimization idea came from the simulation process of the musicians to create music: to draw a parallel between decision variables of the optimization problems and the tone of the instruments, between solution vector and the harmonic tones of a variety of instruments between the optimization targets and the evaluation functions as well as between the populations and the harmony memories. By all these, the problem can be optimized [5].

HS starts by initializing the harmony memory HM. As for every new component, with probability HMC R takes values in HM and introduces local disturbances. The value took the probability HMC R in a variable range, a new value will generate. If the new value of the objective function values better than the worst solution in HM, the later one will be replaced by the former one; and the algorithm will continue to run until convergence or reach the maximum number of iterations. In view of the features of the problems which are needed to be solved in this paper, the improved HS is adopted in this paper. The steps of multi-objective optimization of the clustering routing algorithm are listed in the following,

Step 1. Set some basic parameters, such as the number of clusters, the minimum number of clustering nodes Nm which mainly aim to ensure the accuracy of data transmission and the efficiency of clustering), the data transmission times T etc.
Step 2. Deploy nodes first in some way (such as random or uniform) in the region.
Step 3. Cluster all the nodes in the initial stage of multi-objective harmony optimization method performed for in this paper. Otherwise, only using the algorithm discussed in this paper to perform cluster operation to nodes which still have energy.
Step 4. After the cluster head nodes are determined and by joining the nearest cluster heads through the message communication, the nodes form clusters.

Step 5. The data transmissions of the cluster are T times data transmissions between the nodes and the cluster head node as well as between the cluster head nodes and Sink nodes. In this phase, it is needed to record the energy consumption of nodes and the number of dead nodes.
Step 6. If the number of survival nodes fewer than the number of minimum cluster nodes Na in the system after the data transmissions, it means that the end of the algorithm. Otherwise, one needs to execute steps from 3 to 6 again.

In this paper, based on energy consumption balance as a starting point, the routing technology of wireless sensor network has been thoroughly studied. The paper mainly introduces the structure and characteristics of wireless sensor network, analyzes the research focus of the agreement, and emphatically introduces the clustering routing protocol research situation and solutions, while the two causes of the unbalanced energy consumption of wireless sensor is discussed.

4 Performance Evaluation

4.1 The Construction of Experimental Platform

In order to verify the performance of the algorithm, a set of environmental monitoring system is set up, which is mainly used to monitor the temperature and humidity of the environment. In a square area, that is 50 m × 50 m, 100 cc2430 nodes are randomly deployed and adjust its transmit power so that half price of communication is 100 m (by these, connectivity can be ensured). Each node is carrying two sensors, temperature and humidity sensors, which can gather information from specific nodes (or cluster head or sink node) between regular intervals. The nodes use rechargeable batteries while laptops with the wireless communication act for the sink nodes. The algorithm runs to the sink node whose results will be transmitted in the network through the broadcast. The coordinates of the Sink node are (75, 25), the length of the data message (including control information and data information) is 4000 b, the number of clusters is 4, the number of population is 20, the number of iterations is 200 [6].

4.2 Improving the Performance Evaluation of Algorithm

In order to evaluate the performance of the proposed algorithm, an adaptive binary harmony search algorithm (improved algorithm) is proposed in this paper to compare with the average fitness of the population [7]. With the increase of the number of iterations, the average fitness of the improved algorithm is gradually convergent. Besides, the improved algorithm performs better than the unimproved one (the smaller the fitness is, the better the algorithm is).

The self-adaptability of the parameter HMC R and PAR helps to improve the performance of the algorithm, which proves the validity of the algorithm [8]. On the one hand, the harmony search algorithm is still an essentially random search algorithm, on the other hand, this paper adopts the strategy of making new values to replace the worst

solution in the original population. For all these, the average population of fitness has certain fluctuations.

4.3 Application Verification

To demonstrate the effect of the algorithm in the actual operation of the process, one need to compare the algorithm results that run to the sink node and received data in the monitoring system the by Sink node (only compare the maximum transmission number of the network data throughout the life cycle).

A Sink node running in the algorithm is different from the actual receiving data of the Sink node in monitoring system, and the former is less than the former. The reason is that in the actual routing process, the communication link quality between the nodes is affected by terrain [9]. Obstacles and other factors, resulting in clustering routing protocol performance is reduced. Also, the node need to intercept the channel before data transmission that may consume part of energy and the number of network data transmission will be minimized. The theory proves that the non-uniform distribution strategy can be applied to the algorithm. The analysis shows the wireless sensor.

Network, if the node continues to send data to the base station, even using non-uniform distribution strategy, the entire network cannot achieve full network energy consumption balance, which is due to the decision of a data communication model. Although it is true, the distribution of nodes in the network can achieve the equilibrium of the sub optimal energy consumption as long as it satisfies a certain condition. The simulation of surface, using geometric series non-uniform deployment strategy, with the expansion of the network size algorithm for students [10].

The life cycle is not affected by. In addition to this algorithm in addition to the most outer node cannot achieve energy balance, and the rest of the nodes can achieve energy consumption balance, so that the whole network to achieve a balanced energy consumption. In large-scale network environment, existing algorithms of not too much, this paper introduced the non-uniform distribution strategy based on the algorithm, this strategy can effectively reduce the influence brought by the hot effect, further to avoid energy hole [11]. Theory and simulation show that the non-uniform distribution strategy can be well performed on the basis of the algorithm, and the expansion of the network scale, the network lifetime is not decreased obviously.

5 Conclusions

A multi-objective clustering routing algorithm for wireless sensor networks is proposed in this paper, the distance between sink nodes, the distance between clusters, as well as the network energy consumption are regarded as the optimization objectives in the algorithm. At the time when optimizing the cluster head nodes and cluster member nodes by using improved parameter adaptive binary harmony search algorithm, each sub objective weights in algorithm did male self adaptive adjustment according to characteristics of population evolution in the evolution process, which not only make the algorithm maintain a population diversity instead of avoiding falling into local optimum, but

also ensure the rapid convergence of the algorithm. The experimental results show that comparing to the algorithm, the proposed algorithm can make the network energy consumption more balanced and extend the working time of the network. This paper studies clustering optimization algorithm for homogeneous static nodes. Next, the node mobility and heterogeneity will be then introduced into the clustering routing algorithm. And it will study routing optimization algorithm for Heterogeneity of nodes and the existed situation of a part of the mobile nodes. At the same time, in order to make the algorithm have better adaptability to environment, communication link quality evaluation index will be introduced next, making the algorithm can adapt clustering routing requirements under the complex environment in practical applications.

In recent years, some achievements have been made in the research of wireless routing protocol, but there is still no uniform standard. Even if a theory is feasible, the experimental simulation also showed a good routing algorithm, may be in a different application environment or a new hardware platform, showing much lower than the expected level of. This phenomenon is difficult to change in the short term, it will focus on the development and classification of the main routing algorithm, in a variety of practical applications can quickly find the corresponding better routing strategy. The research work in this paper is very limited, and there are many problems to be solved in the future. The purpose of this paper is to study the energy balanced routing strategy, and there is no in-depth study on the energy hole problem, all the research work is limited to avoid the energy hole, and did not put forward the complete energy hole detection and repair plan. This strategy is based on the static node distribution and homogeneous basis, but in some special scenarios, nodes are mobile, how to use this property to further prolong the network life cycle. In the next step, we will consider the node mobility, while the algorithm itself is simple, energy saving and high efficiency.

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