Computer, Intelligent Computing and Education Technology

Volume 1

Editors: Hsiang-Chuan Liu, Wen-Pei Sung & Wenli-Yao

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COMPUTER, INTELLIGENT COMPUTING AND EDUCATION TECHNOLOGY

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SELECTED PEER REVIEWED PAPERS FROM 2014 INTERNATIONAL CONFERENCE ON COMPUTER, INTELLIGENT COMPUTING AND EDUCATION TECHNOLOGY, CICET 2014, HONGKONG, 27–28 MARCH 2014

Computer, Intelligent Computing and Education Technology

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Computer, Intelligent Computing and Education Technology – Liu, Sung & Yao (Eds)
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Information science and education technology

Computer, Intelligent Computing and Education Technology – Liu, Sung & Yao (Eds)
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Preface

In the past twenty years, Computer Science and Information Technology have become involved in many varied applications throughout the world, with multiple products and rapid market services. They have not only provided industries with new methods, new tools and new products from design, material processing to operation and management process, but are also changing the manners, thinking styles and working environments of people in all fields.

This book contains selected Computer, Information and Education Technology related papers from the 2014 International Conference on Computer, Intelligent Computing and Education Technology (CICET 2014) held in Hong Kong, March 27–28, 2014. The aim is to provide a platform for researchers, engineers, and academics as well as industrial professionals from all over the world to present their research results and development activities in Computer Science, Information Technology and Education Technology.

This conference will promote the development of Computer Science, Information Technology and Education Technology, strengthening international academic cooperation and communications, and the exchange of research ideas.

I am very grateful to the conference chairs, organization staff, the authors and the members of the International Technological Committees for their hard work. We hope that CICET 2014 will be successful and enjoyable for all participants.

January, 2014
Wen-Pei Sung
National Chin-Yi University of Technology

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Computer, Intelligent Computing and Education Technology – Liu, Sung & Yao (Eds)

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The study of Tibetan text clustering based on hybrid parallel genetic algorithm

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ABSTRACT: The domestic and foreign research on text clustering be too numerous to enumerate, related technology is becoming mature. Clustering algorithm is the key technology of text clustering; the choice of algorithm will also affect the final clustering results. At present, the domestic and foreign experts are working on improving algorithm and clustering algorithm integrated application research. However, the research on minority language's text clustering is relatively less, especially the research results about the Tibetan text clustering is very little. In this paper, the Tibetan text clustering of genetic algorithm and K-means algorithm will be research. So as to realize Tibetan text clustering based on hybrid parallel genetic algorithm, and has achieved good clustering results.

Keywords: clustering; Tibetan text; k-means algorithm; genetic algorithm

1 INTRODUCTION

The concept of genetic algorithm is proposed by Bagley J. D in 1967; and the theory of genetic algorithm and method of systematic studied in 1975. This groundbreaking work is initiated by the professor J.H. Holland who works at the University of Michigan.[1] At that time, its main purpose is to illustrate the adaptive process of natural and artificial systems.[2] Genetic algorithm as an efficient parallel global optimization search tools has already accepted by many fields, the application of it in the aspect of data mining is a great value, is an important research topic in the field of data mining.[3,9] Using genetic algorithm to solve the problem with chaos, random and nonlinear for typical characteristics, for the complex problem which other science and technology cannot solve or is difficult to solve provides a new calculation model.[4] For noisy chaotic characteristics of large amounts of data, the genetic algorithm effectively solves the problems.[5]

Genetic algorithm is a global search algorithm, it randomly generated a population, and then simulates the natural evolution towards better evolution, and the individual can be evaluated by the size of the fitness.[6] Genetic algorithm has the self-organizing, adaptive and self-learning characteristics, and evolution of natural selection and make the calculation simple genetic operators are not affected by its search space restrictive conditions (such as continuous and differentiable, unimodal) constraints, and do not need other auxiliary information (e.g., adjustable guide), so the genetic algorithm can obtain higher efficiency, and has the characteristics of simple, easy to operate and general.[7]

Text clustering is a fully automatic processing of text set grouping process; machine learning is a kind of typical guidance process. Text clustering goal is to find such a collection of classes, the degree of similarity between classes as least as possible, and the maximum similarity within the class. As a kind of unsupervised machine learning method, clustering doesn't need training process, also does not need to manual annotation category document in advance, so the clustering technology is very flexible and has higher ability of automated processing, now has become the effective organization, the text information and an important means of navigation, more and more researchers are paying attention on it.

As information processing technology, especially the automatic word segmentation technology and the development of the semantic similarity measurement technology, based on the study of the Chinese text clustering technology got rapid development. However, the research on minority language's text clustering is relatively few. Especially Tibetan information in the direction of research is extremely scarce; just rely on some domestic colleges and universities and scientific research institutes and research department of the Tibetan local related research is not enough. Therefore, through the existing Chinese text clustering technology is applied to the Tibetan text clustering will research

on Tibetan text clustering produces extremely profound significance, to promote the development of Tibetan information processing technology also is significant. This paper mainly studies how Chinese biotechnology based on genetic algorithm is transplanted into Tibetan text clustering, clustering of Tibetan text quickly and accurately.

2 THE KEY TECHNOLOGY OF TIBETAN TEXT CLUSTERING

2.1 *Tibetan text representation*

First met in automatic text clustering is the basic problem of how to make the form of text representation into a computer can understand. Text representation model is the key part of the text clustering, because it directly determines the next parts by use of methods, and finally the accuracy of clustering results. Text representation can be divided into the following four models: Concept Model and Probabilistic Mode, Set Model and Algebraic Model.

1. Concept Model, the Model for the center with concepts rather than with the word or phrase, is a kind of brand-new retrieval Model, with mesh or tree structure to classification and organization, using the distance between concepts of document similarity calculation.
2. Probabilistic Mode, this Model is based on the statistical probability to describe information samples. Probability model by considering entry documents between the statistical probability, than the Boolean model and vector model had greatly improved. Its advantage is the ability to sort information according to the related the descending order of probability sample. The disadvantage is that the probability model does not consider index entries in the information in the sample frequency. And it still assumes that the index entries are independent of each other; In addition, the probability model need to guess initial sample information, and is divided into relevant and irrelevant two collections.
3. Set Model, this Model will be a document representation as only 0 and 1 binary keywords Set forms, it is a Boolean Model. It is a typical representative. The advantage of the collection model is easy to realize. Weakness: the Boolean expression of exact match can lead to retrieve data redundancy or too little, its precise semantics is difficult to transform the general information needs into a Boolean expression, and it is the base of twelve value standard, does not take into account the approximate concept. As a result, the collection model is considered to be the weakest classic methods.
4. Algebraic Model, according to the Algebraic Model, documents consist of a set of n independent eigenvector, and each feature is endowed with a weight. Vector Space Model is a typical representative of the Model, in addition, there are representative of the neural network Model, the latent semantic indexing Model. Similar to the concept of the model is described by characteristics of weight, so can accurately measure the similarity between the documents and improve the efficiency of information processing, in addition, the part of the model matching strategy applicable to extract more similar samples.

This article uses the Vector Space Model, Vector Space Model is to use the mathematical Model of Space Vector to represent text information, and one of the most famous of the retrieval system of this Model is the smart system. In vector space model, each dimension represents a keyword, when a keyword in the text, it corresponds to a weight of non-zero value. When to feature selection in text, do not need to consider a lot of syntax and grammar information, also do not need to semantic processing documents. Vector space model of the specific said is as follows:

Given a document $D = \vec{D}$ ($Term_1$, W_1; $Term_2$, W_2;…; $Term_n$, W_n), if $Term_k$ in the text can be repeated and there should be a sequence, the relationship between analysis still has the certain difficulty. In order to simplify the analysis, can temporarily don't consider $Term_k$ order and require different $Term_k$ in the document, it can be consider $Term_1, Term_2, ..., Term_n$ as an n-dimensional coordinate system, and $W_1, W_2, ..., W_n$ for the corresponding coordinates, thus $D(W_1, W_2, ..., W_n)$ is as a vector of n-dimensional space, called $D(W_1, W_2, ..., W_n$ text D vector said. Among them, the$Term_i (i = 1, 2, ..., n)$ of the vocabulary of the text, $W_i (i = 1, 2, ..., n)$ said its corresponding weights.

VSM's main advantage is that it simplifies the representation of a natural language, converts the complex language simple algebra content, and can be applied in mathematics calculation method for processing text; greatly reduce the complexity of the problem, at the same time to ensure the time complexity requirements of many applications. At the same time, VSM does not depend on a particular field; the spatial similarity can be utilized to approximate the semantic similarity.

2.2 *Tibetan text clustering*

Clustering is the process of a data set is divided into several groups or classes, and the data objects within the same group have high similarity, and the data objects in the different groups are significantly different. Similarity is calculated according to the

description object attribute values. Clustering and classification of the difference is that the latter learning obtain classification of prediction model used by the data is known (class-labeled, belongs to supervised learning method, clustering analysis and the data analysis and processing are no predetermined category of belonging, the class mark in clustering analysis of the data set is not exist, belongs to unsupervised learning, in many cases has stronger practicability.

2.2.1 *Formal description of the text clustering*
Text clustering formalized definition as:

$$D = \bigcup_{i=1}^{N} d_i$$

on behalf of a text data set. C_j is a subset of D, then the task of text clustering is divided D into k subsets, satisfy its:

$$D = \bigcup_{j=1}^{k} \mathrm{C}_j, C_{j1} \cap C_{j2} = \varnothing$$

Above as the basic conditions, only the text clustering is more important which is to make a bunch of the text on the semantic similarity and as far as possible and text as far apart or different from other clusters, namely:

$$max\left(sim(d_i, C_j) \right),\ d_i \in C_j 1$$

$$min\left(sim(d_i, C_j) \right),\ d_i \notin C_j$$

2.2.2 *Tibetan text clustering process*
Tibetan text clustering is a complex data processing; it has essentially different with other clustering methods. Research clearly Tibetan process and contents of the text clustering is very important. In this paper, the model of Tibetan text clustering process is shown in Figure 1.

Text clustering to the pretreatment of the document in the first place, then the text said the final clustering. Text preprocessing approach usually cut including word processing; remove the stop, filtering web symbols, etc., as a result, the document processing into space vector or keywords list. The Chinese document representation is divided into feature extraction and feature reconstruction step or two. First by feature extraction algorithm according to the characteristics of the evaluation function and the setting threshold, from all the characteristics of the concentrated extract an optimal feature subset; Again after feature extraction of the optimal feature subset request according to

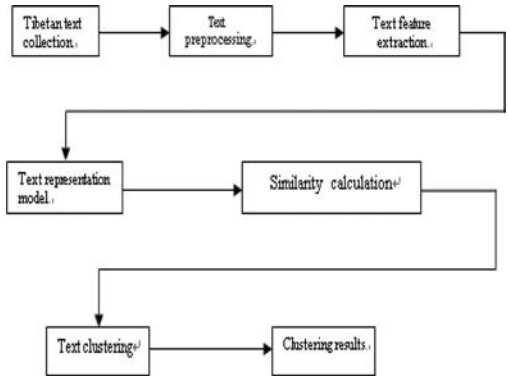

Figure 1. Tibetan text clustering process model.

the clustering method, weight adjustments, highlight the important word clustering and build text representation model; According to the definition of Chinese text strings' similarity, judge the distance between the text; After the use of text clustering algorithms, clustering results are obtained and displayed.

3 HYBRID PARALLEL GENETIC ALGORITHMS

Text and indenting Genetic Algorithm is a kind of very effective global optimization Algorithm, is proposed by Holland in the United States in the 1960s, is mimic natural biological evolution mechanism of random search Algorithm, and used in processing of traditional search method is difficult to solve complex optimization problems. With the acceleration development of the follow-up related research work, the content of the genetic algorithm has been further supplement and improvement of basic formed a set of complete theoretical system. Therefore, the study of the genetic algorithm will gradually turn to the improvement of genetic algorithm, (such as adaptive genetic algorithm, hierarchical genetic algorithm and parallel genetic algorithm, genetic algorithm based on niche technology, etc.) and based on the genetic algorithm be combined with other hybrid intelligent optimization algorithm (such as quantum genetic algorithm, genetic algorithm and immune genetic algorithm together, etc.).[8]

Among them, the parallel genetic algorithm is an effective genetic algorithm for solving the problem of premature convergence, it take full advantage of the parallelism of genetic algorithm, the efficiency has been greatly improved, guarantee the accuracy of the algorithm are also obtained. But the efficiency is only through the parallelism

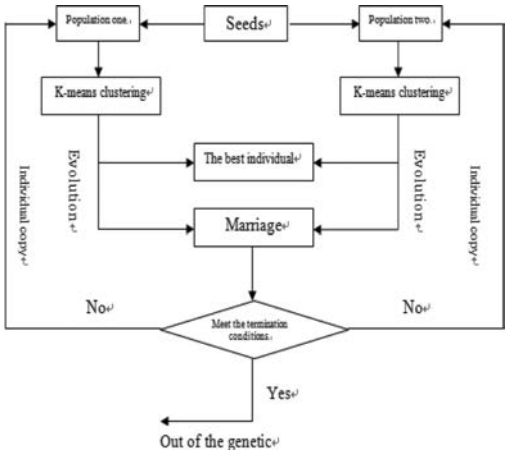

Figure 2. Hybrid parallel genetic algorithm model.

of the algorithm to obtain, has not been given in the process of calculation using heuristic approach to local optimization.

K-Means algorithm, however, is a kind of strong local search ability of clustering algorithm, it fully considered in the process of operation using heuristic method for clustering center of the excavation, so the algorithm efficiency is very high. However, K-Means algorithm is global search ability is bad, for the selection of the initial clustering center is relatively sensitive, so the algorithm precision is not guaranteed.

Therefore, this article on the choice of clustering algorithm priority hybrid parallel genetic algorithm, the hybrid parallel genetic algorithm can give full play to the efficiency of the K-Means algorithm and local search ability, and parallel the parallelism and global optimization ability of genetic algorithm, so as to rapidly and accurately find the initial clustering center. The model is shown in Figure 2.

4 FEATURE SELECTION BASED ON HYBRID PARALLEL GENETIC ALGORITHM

The main purpose of the feature selection is to reduce the dimension of feature vector and don't change feature vector representation. Feature vector selection also produces a feature vector; the result of the characteristics is one of the items in the original feature vector subset. Feature selection based on hybrid parallel genetic algorithm includes: chromosome coding and the initial population establishment, set of fitness function, genetic operator design (including selection operator, crossover operator and mutation operator), the setting of the termination conditions.[10]

4.1 *Chromosome coding and the establishment of the initial population*

Chromosome coding with binary coding, coding method is as follows: for an individual (chromosome) S, and the original eigenvector v, if v is an n-dimensional vector, then the Si is encoded into a bit binary number, everyone in Si is equal to a gene of the chromosomes. If the value of first x in Si is1, meant V in the x dimension feature is selected; if the value is 0, meant y dimensions of V on the characteristics of the item is not selected. Obviously, the characteristics of any kind of combination, there is only one string with the matching.

The selection of initial population with random method, using random function to produce N chromosome form the initial group.

4.2 *Fitness function*

Natural selection, survival of the fittest" is the center of the genetic thinking, how to determine the individual fitness problems is the key to evaluate the individual effect. This article uses the average similarity to represent the fitness of the individual. Text is represented as feature vector, the whole text collections as a vector space, this text vector space can be calculated the average similarity between the feature vectors. If a word has a good degree of differentiation, as it has joined, the average similarity becomes smaller; On the other hand, if a degree of differentiation of words is poor, so the average similarity. Feature selection task is to select the degree of differentiation of good words, namely small characteristic collection of the average similarity, such as genetic algorithm with the average similarity of individual fitness is appropriate.

For an individual S_i, its average similarity function computation formula is as follows:

$$C(i)=\frac{1}{N}\sum_{j=1}^{N}D(S_i,S_j)$$

Among them, $D(X,Y)=(\Sigma(X_i-Y_j)^2)^{1/2}$ can be used to calculate the Euclidean distance of individual X and Y, and $X_i = W_i * b_i$. W_i is the original feature vector of the ith feature weights, bi is the ith binary values of individual X. D (X, Y) value, the greater the degree of similarity between X and Y is smaller.

Therefore, the fitness function is:

$$F_i=\frac{1}{C(i)}$$

The greater the value of F_i is, the higher the fitness of the individual will be.

4.3 *Select operator*

The selection operator is the process of choosing the relative good individual adaptive value from the current group to generate the mating pool. At present, there is mainly the choice of fitness proportion, the Boltzmann selection and sorting, etc. In this paper, I will use the Boltzmann selection. Different stages in the process of population evolution require different selection pressures. Early stage selection pressure is small, because I want to poorer individuals to have certain opportunities, to make groups maintain higher diversity; Later stage selection pressure is bigger, we hope that the genetic algorithm to reduce the search neighborhood, to speed up the current optimal solution to improve. In order to evolutionary selection pressure in the process of dynamic adjustment group, Goldberg Boltzmann selection method is designed. Individual selection probability is:

$$P_s\left(a_j\right) = \frac{e^{f(a_j)/T}}{\sum_{i=1}^{n} e^{f(a_i)/T}}$$

Among them, $T > 0$ is annealing temperature. T as the iteration to gradually reduce, selection pressure will rise accordingly.

4.4 *Crossover operator*

Crossover operator in the genetic algorithm is an evolutionary algorithm with the primitiveness of unique characteristics. Crossover operator is to imitate the genetic recombination process of sexual reproduction nature, which plays a role in passing on to the original good genes to the next generation of individuals, and generating a new individual which contains more complex genetic structure. Crossover operator is usually a single point crossover and multipoint crossover and uniform crossover, etc.

This article will adopt the method of single point crossover, randomly setting an intersection in the string of individual coding. According to the set of the crossover probability of Pc, at this point will have an exchange of two matching individual part of the chromosome, and it will produce two new individuals.

Single point make righteous operation schematic is shown below:

Before cross is as follows:
X: 1010 0110 | 00
Y: 0011 1101 | 11

After cross is as follows:
X: 1010 0110 | 11
Y: 0011 1101 | 00

4.5 *Mutation operator*

Mutation on chromosome mimic natural biological evolution a genetic mutations occur, thus changing the structure of the chromosome and physical properties. In genetic algorithm, we can through the mutation probability Pm stochastic inversion of one allele of a binary character values to realize the mutation operator. Mutation is determined by the mutation probability, mutation probability though only affect the local search ability of the algorithm. However, if the mutation probability is too low, some useful genes will not be able to enter the choice; if the mutation rate is too high, future generations may lose from the parent generation inherit good features; In general the value of the mutation probability Pm is between 0.001 and 0.10.

4.6 *Termination conditions*

When the fitness of the best individual to a given threshold, or the fitness of the best individual and group fitness rise no more, or the number of iterations reaches algebra, termination algorithm. Default algebraic average generation is set to 100–500.

5 RESULTS AND CONCLUSION

Experiment is an effective way to judge the algorithm is good or bad, because the new method in the aspect of theory has not been proved strictly, so it is hard to avoid errors, we should carry on the objective evaluation, and try our best to improve in the later research.

5.1 *Experimental data*

Experimental data of this article is obtained from major Tibetan sites, involving politics, economy, culture and education, information technology, religion, ecological environment, health care, and there are 600 Tibetan texts. As shown in Table 1.

5.2 *Experimental steps*

The steps of Text clustering as follows:

1. Text segmentation for the test data;
2. The text is represented by vector space model;
3. Decreasing dimensions;
4. Using genetic algorithm to optimize the data which has been decreased the dimensions;

Table 1. Experimental data.

Subject category	Politics	Economy	Culture and education	Information technology	Religion	Ecological environment	Health care
The number of text	100	50	100	50	50	100	150

Table 2. Experimental results.

Algorithm	K-means	GA	HPGA
The average accuracy	60%	63%	67%
F_1	0.65	0.71	0.76

5. Using the K-means algorithm to cluster analysis for optimized data;
6. Calculating the value of F_1 and analyzing.

5.3 *The evaluation method of clustering results*

Estimating the evaluation of clustering results is good or bad basically has the following several indicators: Precision, Recall and F_1. P_r is used to show the correctness of the clustering, and R_e is used to characterize the integrity of the clustering. P_r and R_e must be considered at same time, so we introduce a new evaluation index F_1. As shown in the following formula:

$$F_1 = \frac{P_r \times R_e \times 2}{P_r + R_e}$$

The greater the value of F_1 is, the effect of clustering will be better.

5.4 *Experiment results analysis*

The experimental results are shown in Table 2.

From the experimental results, we can learn that the k-means algorithm clustering accuracy is lower. Comparing to the k-means algorithm, GA algorithm improved. Tibetan text clustering based on hybrid parallel genetic algorithm works best. Errors mainly concentrated in Tibetan word segmentation, feature selection and calculation of similarity between texts, these will be our next work.

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The PVDF-based method for wind turbine blades structural health monitoring

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ABSTRACT: Wind energy is paid more and more attention by the countries all over the world. With the rapid development of wind power, the accidents of wind turbine damage is also increasing year by year, especially the accidents caused by the blade breakage are the most common. Monitoring the structural health of wind turbine blades is a problem that urgently needs to be addressed. However, the domestic researches of wind turbine blade are mainly concentrated in manufacture and design. As a result, a method for monitoring the blades' structural health has been put forward and the PVDF monitoring sensor has been designed and produced. The sensor can measure the blade's resonance parameters at the frequency of 6~2000 Hz. Further, collecting these parameters will support qualitative analysis to judge whether the blade is cracked.

Keywords: wind turbine blade; PVDF; structural health monitoring; resonance displacement; frequency response curve

1 INTRODUCTION

With the advent of 1970s world energy crisis, wind power has been paid more and more attention by the countries all over the world, and the main use of wind energy is wind power generation. With the rapid development of wind power, the accidents of wind turbine damage are also increasing year by year. Any position of wind turbine is likely to damage, such as generator, gearbox, blade and so on. The damage caused by the blade breakage is the most frequent in statistics and also causes the greatest loss. What's worse: this kind of damage is often accompanied by serious secondary disasters (destroy of the building nearby, vehicle damage, casualties, etc.). The blade is the first step to switch wind energy into electricity. The blade damage will directly lead to the paralysis of the wind turbine. In order to reduce the risk of loss during the operation of a wind turbine, and reduce the maintenance cost for wind turbine blades, the health of the blades must be paid high attention, and the study on blades damage identification must be strengthened.

Wind turbine blades structural health monitoring is a problem which urgently needs to be addressed, but the domestic researches on wind turbine blades are mainly concentrated in design and manufacture. This paper presents a method for monitoring the blades' structure health. By utilizing PVDF film which has the advantages of fast response, high sensitivity, and good mechanical properties and so on, the monitoring sensor has been designed and produced. The sensor can measure the resonance displacement of a blade at the frequency of 6~2000 Hz. After acquiring the inherent frequencies of a blade when it is in healthy state and when it is in cracked state, the frequency response displacement curves can be recorded. By comparing the two different frequency response displacement curves, it is intuitional to judge whether the blade is cracked.

The remainder of this paper is organized as follows. In Section 2, we introduce the chemical constitution and advantages of PVDF film at first. Then we describe the design and producing of the PVDF monitoring sensor. At last, we test the sensor and obtain the performance indicators of the sensor. After analyzing the wind turbine blade health monitoring experiments' consequences, Section 3 expounds the principle of the monitoring method and the procedure of using it in an actual monitoring. We end our paper with a summary in Section 4.

2 THE PVDF MONITORING SENSOR

2.1 *PVDF film*

PVDF (Polyvinylidene fluoride) is a high molecular polymer type of new sensing material, and its molecular formula is:

$$-\left(CH_2 = CF_2\right)_n - \tag{1}$$

It is constituted by two fluorine atoms which substitutes ethylene molecules in the two hydrogen atoms. PVDF film has the advantages of fast response, wide frequency response, linearity, good reproducibility, wide dynamic range, easy to match the acoustic impedance, high sensitivity force electrical conversion, high strength mechanical properties. Besides, PVDF film is light, flexible, extremely thin, impact-resistant, invulnerable to the pollution of water and chemicals, and easy to make into any shape ranging from tablets or tube. Polarized the PVDF film, the film will have a piezoelectric characteristic. Further explanation is that when withstands the pressure of a certain direction, PVDF film will generate a charge which is equal in magnitude and opposite in direction in the upper and lower plane of polarization. Piezoelectric effect reflects the interplay between electrical and mechanical quantities. PVDF film is used as vibrating sensor, which the influence on system vibration is little. So the PVDF sensors have been widely used in vibration measurement and monitoring structural mode of beam.

2.2 *Sensor design*

After consulting literature and doing experiment repeatedly, we selected a sine curve boundary as the shape of the PVDF monitoring sensor, as shown in Figure 1. Thus the sensor will obtain the best frequency response performance, and minimize the influence on the wind turbine operation.

In the case of one dimension, the sensor attached to the surface of the object will not affect the dynamic balance and fluid characteristics of the object. The relationship between vibration response and output charge of the PVDF monitoring sensor is:

$$q = -Ze\int_0^l \sin\left(\frac{\pi y}{l}\right)\frac{d^2w(y)}{dy^2}dy \tag{2}$$

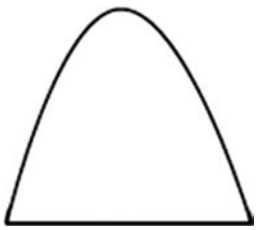

Figure 1. The shape design of the PVDF monitoring sensor.

In the formula, e is piezoelectric stress constant, $\sin(\pi y/l)$ is boundary shape function, l is length of sensor, $w(y)$ is the displacement function and Z is thickness parameter. The sensor can acquire the resonance parameters of the wind turbine blade, such as resonance displacement, etc.

The conductive silicon rubber is used as the base substrate of the sensor. After cutting the PVDF films and conductive silicon rubber into the shape we designed, bond them together with conductive silver paste. The structure of the PVDF film which is domestic produced is composed of three layers, as shown in Figure 2.

2.3 *The sensor's performance indicators*

Using function signal generator, power amplifier, vibration exciter and digital oscilloscope, apply sinusoidal excitation signals on the sensor for testing. Change the amplitude and frequency of the excitation signal continuously, the response of the sensor is changing accordingly, and the response waveforms coincide with the excitation waveforms. Change the given frequency excitation signal and repeat the test. The record of the frequency responses from the tests is drawn in Figure 3. The deviations of the frequency responses are calculated respectively, as shown in Figure 4.

The figures show that the response frequency deviation is the minimum when the excitation frequency is 750 Hz, and the response frequency deviation will reach or even exceed 5% when the excitation frequency is below 6 Hz or above 2000 Hz. Hereby, the wind turbine blades health

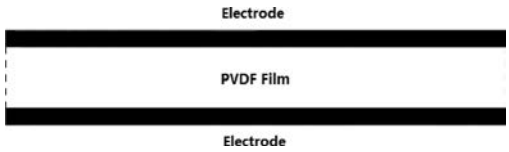

Figure 2. The three-tier structure of the PVDF film.

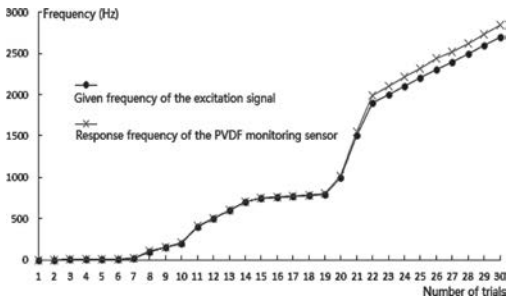

Figure 3. The test of the PVDF monitoring sensor.

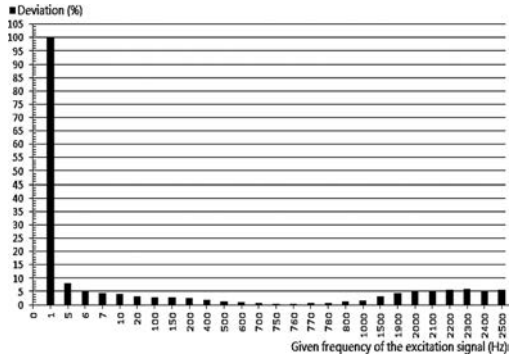

Figure 4. The deviation of the response frequency.

monitoring experiment is implemented at the frequency of 6~2000 Hz.

3 WIND TURBINE BLADE HEALTH MONITORING EXPERIMENTS

In the process of the wind turbine operating, the amount of data collected is very large, so the multifunction data acquisition card is used for the signal real-time processing, which is able to cut a certain scientific research cost meanwhile. The PVDF monitoring sensor has high internal impedance, so the signal must pass through the signal conditioner for impedance matching, signal amplification and filtering processing before entering the multifunction data acquisition card. The multi-function data acquisition card and the host PC communicate by USB2.0. In addition, the experimental instrument also need white noise signal generator, power amplifier, oscillator, wind turbine blade model (the experiment dedicated) and so on.

The PVDF monitoring sensor is attached to the wind turbine blades by silver conductive adhesive. The white noise signal generator generates a white noise signal which drives the oscillator after being amplified by the power amplifier. The oscillator applies a vibration force on one end of the wind turbine blade, and the blade starts to vibrate. The sensor feels vibration and generates electric charge. After the processing through the signal conditioner and the multi-function data acquisition card, the signals enter the host PC to store.

In the experiment, set 6~2000 Hz as the output range of the white noise signal generator. There are two pieces of wind turbine blade model which are processed by the 8th beam tablets (length 80 mm, width 20 mm and thickness 5 mm). One wind turbine blade model is cracked in varying degrees artificially, and the other one is keep intact. Conduct the experiment four times with different blades and identity the differences between the healthy blade and the slight, moderate and serious cracked blade, as shown in Figures 5–7. From the figures, we can obtain the following conclusions:

1. The maximum amplitude of the frequency response displacement curve is about 1050 Hz if the blade is healthy. At this frequency, the resonance displacement of the blade is the max. The blade's inherent frequency is $f_0 = 1050$ Hz.

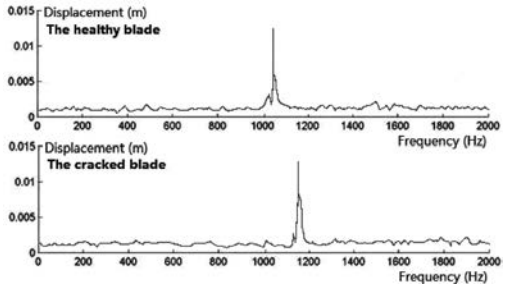

Figure 5. Contrast of the healthy blade and the slight cracked blade.

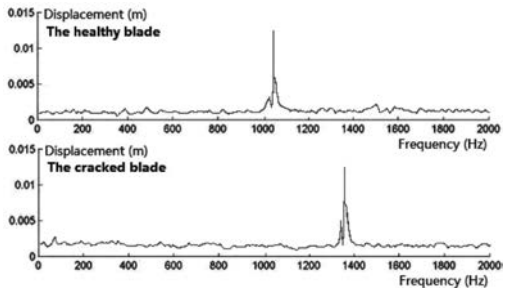

Figure 6. Contrast of the healthy blade and the moderate cracked blade.

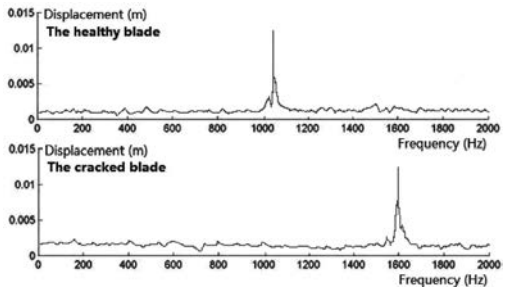

Figure 7. Contrast of the healthy blade and the serious cracked blade.

2. When the blade is cracked slightly, the maximum amplitude is about 1150 Hz, and the blade's inherent frequency is $f_1 = 1150$ Hz.
3. When the blade is cracked moderately, the maximum amplitude is about 1350 Hz, and the blade's inherent frequency is $f_2 = 1350$ Hz.
4. When the blade is cracked seriously, the maximum amplitude is about 1600 Hz, and the blade's inherent frequency is $f_3 = 1600$ Hz.
5. It is apparent that $f_0 \neq f_n (n = 1, 2, 3)$.

By comparison, the response displacement curve of the cracked blade has changed obviously. The changes of the blade's inherent frequency concomitantly lead to the three different frequency response displacement curves. In other words, the changing of the blade's inherent frequency means that the blade is getting to crack.

In an actual monitoring, we firstly measure a new quality wind turbine blade under a white noise signal excitation and record the frequency response displacement curve, get down f_0 as the healthy standard. After the turbine operating, measure the blade under the same white noise signal excitation at set intervals, record the frequency response displacement curve and $f_n (n \in N^+)$. Comparing f_0 and f_n is able to judge whether the blade is cracked intuitionally.

4 CONCLUSION

This paper puts forward a method to monitor the blades' structural health. By utilizing PVDF film which has the advantages of fast response, high sensitivity, and good mechanical properties and so on, the PVDF monitoring sensor has been designed and produced. The sensor can measure the resonance displacement of a blade at the frequency of 6~2000 Hz. After acquiring the inherent frequencies of a blade when it is in healthy state and when it is in cracked state, the frequency response displacement curves can be recorded. By comparing the two different frequency response displacement curves, it is intuitional to judge whether the blade is cracked. This method is of effectivity, utility, simple operation, intuitive judgment, and momentous engineering value. Based on this method, there is a broad application space in the research field of wind turbine blades damage identification and flexible rigid (windmill blades, turbine blades, helicopter blades, etc.) structural health monitoring.

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Research on universal data push mechanism based on XMPP protocol and IAIDL for smart home

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ABSTRACT: The universal data push mechanism is considered for smart home to implement data push service between terminals with different systems. With the development of smart home and mobile devices, demand for integration between smart home terminals and mobile devices was growing rapidly. In order to solve the incompatibility between smart home terminals and mobile devices, a universal data push mechanism based on XMPP protocol and IAIDL was considered to integrate different terminals in smart home and process internal and external data push services simultaneously. So connections inside and outside of smart home can be better implemented, and expansibility, efficiency and user experience of smart home can also be improved.

Keywords: smart home; data push; XMPP protocol; IAIDL

1 INTRODUCTION

Smart home is the main direction of the study of household electrical appliances. It is the combination of communication technology, computer technology and consumer electronics technology, and this combination enable traditional home appliance to implement digitalization, intellectualization and networking.[1]

With the development of smart home and mobile device, demand for integration between smart home terminals and mobile devices was growing rapidly. In this paper, based on the existing research results, the main contribution is to combine the XMPP protocol push mechanism and IAIDL language, and put forward a universal data push mechanism suitable for smart home. This mechanism can integrate different terminals in smart home and process internal and external data push services simultaneously. So connections inside and outside of smart home can be better implemented, and expansibility, efficiency and user experience of smart home can also be improved.

2 RELATED WORK

In the implementation of data push for smart home, XMPP protocol communication and connections between mobile devices and home appliance equipment are two important research aspects.

XMPP protocol uses client–server system architecture. Data transmission between terminals should all go through XMPP server. XMPP introduces the TLS in server communication mechanism for data encryption to ensure the data security in the process of transmission, and uses SASL protocol on XML stream authentication.[4]

As is shown in Figure 1, XMPP protocol contains three types of entities, which are XMPP client,

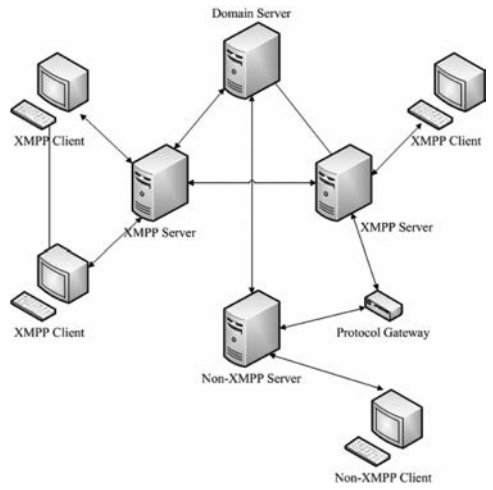

Figure 1. XMPP framework.

XMPP server and protocol gateway respectively. Among them, the protocol gateway is responsible to interconnect XMPP system with the non-XMPP system, meanwhile the XMPP server can also communicate with each other, which forms the distributed network composed of XMPP server.[5] The terminals connected to XMPP network can not only communicate with the terminals connected to the same server, but also communicate with the server on the Internet.[6]

Current mainstream systems for smart terminals such as Android and iOS have already had comparatively mature push mechanism based on XMPP protocol. For instance, XMPP protocol can be applied on the iOS platform to build Instant Messaging system, and real-time data push in the system can be implemented by adopting the technology of real-time compression of XML data in wireless network.[6] XMPP protocol can also be applied on the Android platform to build push platform by using the Node—XMPP libraries and ASMACK repositories.[7]

IAIDL specification language was originally put forward for the study of universal remote control in smart home system. The state of each terminal can be described by IAIDL specification language, and this information enables terminals to interact with universal remote by smart gateway which is running IAIDL interpreter and embedded database applications in order to implement universal control's manipulation to the entire smart home system.[1] A method has already been proposed to express IAIDL specification in the XML document.[3]

3 SYSTEM ARCHITECTURE

Studies above have shown that to implement data push in smart home, the combination of XMPP protocol and IAIDL specifications written in XML is more feasible.

The universal data push mechanism designed in this paper is shown in Figure 2. Each terminal is connected with management through smart home gateway, and the management server is the core of the mechanism, which applies XMPP protocol to handle internal and external data push services simultaneously. Push server also applies XMPP protocol, and it is responsible to send a variety of data to the management server from the cloud push server, and send status information and subscription request to the cloud push server from the management server. The cloud push services include real-time weather push, subscription push and program recommendation, etc. which can be customized according to the current status of smart home and user's subscription request.

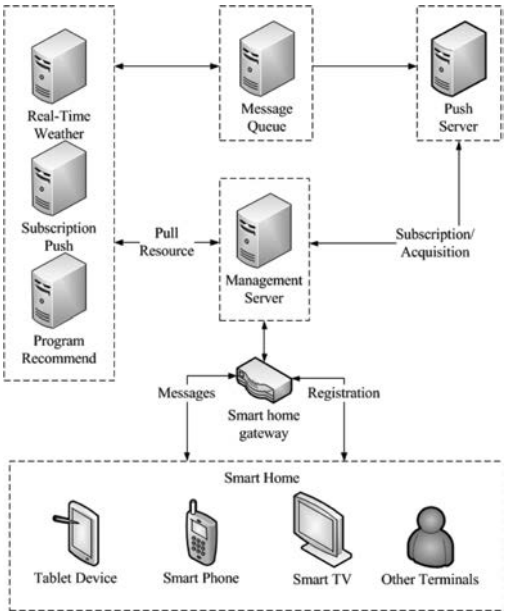

Figure 2. Universal data push mechanism for smart home.

When interacting with home appliances terminals, firstly we will define function interfaces of smart home appliances according to IAIDL specification and their function, and create interface definition text.[4] Then, interface registered senior text and interface invocating framework senior text will be created by IDL compiler, and compiled into an executable program with XML protocol high-level language text by high-level language compiler. Once the smart home appliance terminal is to be registered in smart home gateway, equipment registration packet created according to XML protocol will be sent to the gateway, and complete the registration of equipment interface service. Once push request is received, the corresponding interface will be invoked by interface adapter, and the equipment API will be invoked by execute interface program. Finally driver will drive hardware interface to complete the operation requested.[4]

4 PUSH MECHANISM

4.1 *Communication module*

The main function of XMPP communication module in the smart home terminal is to communicate with the management server, and to implement the push operation between the management server and terminals. XMPP communication

module is mainly to implement the following functions:

1. Registration: registration is needed when new equipment is deployed. Terminal accounts should have been registered in advance before the system is deployed.
2. Login: terminals will automatically login to the XMPP server after starting up, and do some message communication after login.
3. Subscription: predefined alerts between terminals and servers will be implemented by using subscription mechanism.
4. Send messages: communication module will receive messages from control module, transform them into XMPP message encapsulation format, and send them to the XMPP server.
5. Receive messages: communication module will transform command messages received from management server into local message format, and transmit them to the control module.
6. File transfer: communication module will implement file transfer between smart home terminals and management server.

4.2 *XML stream format*

In push mechanism for smart home, XML node and XML stream is the carrier of messages transferred between different entities. XML stream contains XML elements transferred between two entities, and each XML node represents its own information, which implements different functions.[7] XMPP protocol defines three top XML nodes: <presence>, <message> and <iq>. Among them, <presence> node represents the subscription state of the corresponding entity, with which each terminal can release their online status, and can also query the online status of its subscribed entities; <message> node represents messages pushed from one entity to another, and it describes contents such as source node and destination node of the message, form and content of the message, etc.; <iq> node manages the conversion between two entities in XMPP server, and supports the query and response of the XML format between entities.[5]

In the internal data push, the state information and operation information of electrical appliances terminal can be represented by XML nodes written in IAIDL specifications, and these messages can be included in <message> node while transmitting. XML written in IAIDL specifications includes nine kinds of XML nodes. Among them, there are four kinds of nodes describing attributes of the home appliance: <id> represents the unique identification of the type of home appliance, <name> represents the English name of the equipment, <manufacture> represents the name of the manufacturer, <model> represents the unique identification of each home appliance. Besides, there are five kinds of nodes describing operation information: <operationname> represents the name of operation, <operationtype> represents the type of operation displayed on the interface, <operationcurrent> represents the current state of the home appliance, <operationvalue> represents the new status value user want to change into, <operationdefault> represents the default value of the operation when the requested operation fails.

4.3 *Internal data push flow*

Internal data push for smart home includes the push operation of real-time state information and operation request between terminals and management server. Figure 3 depicts the data push flow between terminals through the management server. Specific communication flow is:

Step 1, XMPP module of the pusher terminal will establish a TCP connection with XMPP server.

Step 2, XMPP module of the terminal will send an XML initialization stream to the XMPP server in order to get the server's response, so as to determine whether the server is available. An XML response stream will be sent back to the terminal if the server is available.

Step 3, the management server will attempt to shake hands using established TCP connection. If it fails, XMPP server will disconnect the TCP connection. If it is succeed, XMPP module of the terminal will send a new XML stream to the XMPP server, and the server will reply a certified stream. If the client authentication is succeeded, the terminal will request to establish a conversation. If the stream the server returns contains resource binding characteristics, XMPP module of the terminal will bind a specific resource to the stream by IQ node.

Step 4, after the conversation is successfully established, the pusher terminal will encapsulate its

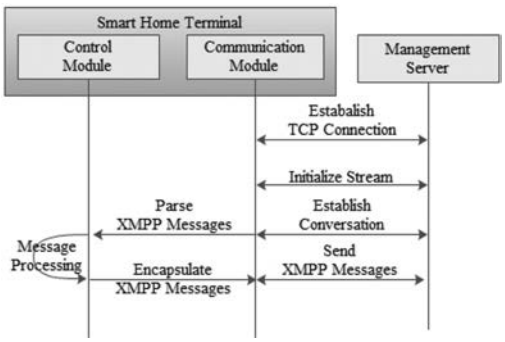

Figure 3. Internal data push flow for smart home.

status information or operation request into XML stream, and send them to the management server.

Step 5, the management server will classify information pushed from the terminal, and if the information needs to push to another smart terminal, then the server will connect to the corresponding terminal according to steps 1 to 3.

Step 6, after receiving the pushed information, the receiver terminal will parse it from XML to the local information, and then execute the corresponding operation. After the operation is completed, the terminal will encapsulate the response information into XML, and send it back to the management server.

4.4 *External data push flow*

External data push for smart home includes the push operation of customized information from the cloud to smart terminals and the push operation of real-time state information and operation request from terminals to the cloud. Figure 4 depicts the data push flow from the cloud to a specific terminal through the push server and the management server. Specific communication flow is:

Step 1, the cloud will send push request to the push server, and establish conversation with the management server through the push server. The process is similar to steps 1–3 in 4.3.

Step 2, the push server will establish connection with the corresponding target terminal, and send messages to the communication module of the terminal after conversation is established.

Step 3, after receiving push information, the smart terminal will parse the XML stream into local information, and display it to the user. The push flow of alert information ends here. If the user needs to request the corresponding resources from the cloud after selecting the particular information, then the flow continues.

Step 4, the communication module of the smart terminal will encapsulate the user's requests into XML stream, and send them to the cloud through the push server. After parsing, the cloud will send the corresponding resources to the management server. Then the management server will send an XML stream to the smart terminal to complete the resource-binding operation, and then send the corresponding resource to the smart terminal. After parsing the resource into local resource, smart terminal will display it to the user.

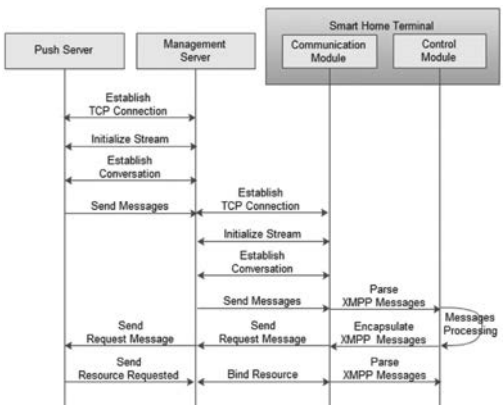

Figure 4. External data push flow for smart home.

5 CONCLUSIONS

This paper put forward a universal data push mechanism suitable for smart home, put forward the concept of external and internal data push, and by adopting the XMPP protocol architecture, enabled terminals with different system to access to smart home using unified communication protocol. In the mechanism proposed in this paper, the management server based on XMPP protocol could handle external and internal data push simultaneously, which laid the foundation for the push data's intelligent unified handling. Current mainstream mobile operating systems have already had comparatively mature XMPP protocol communication mechanism, therefore at present most of the mobile terminals can better access to smart home applied with the push mechanism proposed in this paper.

ACKNOWLEDGEMENT

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Stereo vision calibration based on Elman neural network

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ABSTRACT: In order to improve the accuracy and stability of stereo vision calibration, a novel stereo vision calibration approach based on Elman neural network is presented. The Elman neural network is utilized to build spatial mapping relationship. In the process of modeling, the Levenberg-Marquardt optimization algorithm is introduced as a criterion to train the neural network. Experiments demonstrate that the proposed approach is capable of calibrating 3D location more accurately. It is a convenient way to calibrate the stereo vision without specialized knowledge of stereo vision.

Keywords: stereo vision calibration; Elman neural network; Levenberg-Marquardt optimization algorithm

1 INTRODUCTION

Stereo vision calibration is an important issue in computer vision (Wang 2010, Zeng 2010). Accurate calibration is especially crucial for stereo vision application, such as depth measurement, three dimensional reconstruction, robotic location and object tracking.

The objective of stereo vision calibration is to learn the mapping from 2D image plane to 3D world. Several stereo vision calibration approaches have been proposed, while some camera models have also been presented to model the imaging procedure. A comprehensive status of stereo vision calibration is given in Weng's review (Weng 1991). Gonzalez also evaluates some famous calibration approaches in respect of stability and accuracy (Gonzalez 2005).

In recent years, more and more calibration approaches based on neural network (Xing 2007, Ge 2008, Wen 1991, Chen 2012) are proposed. In contrast with traditional calibration approaches, this kind of approach is capable of calibrating stereo vision without some special explicit distortion models. Some approaches learn the spatial mapping relationship based on Back Propogation neural network (BP) (Xing 2007, Wen 1991), while some researchers base their methods on Radial Basis Function neural network (RBF) (Ge 2008) or GMDH neural network (Chen 2012).

In this paper, we present a comparison between some calibration approaches based on neural network, and propose a novel stereo vision calibration approach based on Elman neural network. The remainder of this paper is described as follows: Sec. 2 introduces the Elman neural network. In Sec. 3, we describe the proposed stereo vision calibration approach based on Elman neural network. Then the experimental evaluation of the proposed approach is described in Sec. 4. Finally, Sec. 5 includes some conclusions and further research directions.

2 ELMAN NEURAL NETWORK

Elman neural network is a partial recurrent network model first proposed by Elman (Elman 1990). It is a special kind of feed-forward neural network, which has extra local memory neurons and feedback loop. The Elman neural network is capable of approximating a nonlinear system without an explicit physical model.

An Elman neural network has four kinds of layers (Fig. 1): input layer, hidden layer, context layer and output layer (Chen 2008). The context layer is utilized to constitute the back-forward loop, from which the hidden layer selects input. In comparison with other forms of feed forward neural network, the Elman neural network is sensitive to history of input data by this mechanism.

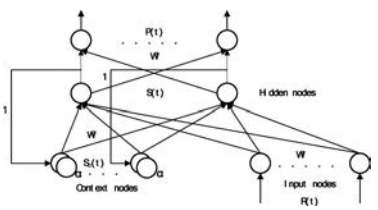

Figure 1. Structure of the Elman neural network.

3 STEREO VISION CALIBRATION USING ELMAN NEURAL NETWORK

Stereo vision calibration is actually to build the mapping model between 2D image plane and 3D world. However, this model exhibits a serious nonlinear phenomenon owing to all kinds of distortion, such as radial distortion and decentering distortion (Weng 1991), and all current imaging models cannot fix it well.

In this paper, a novel stereo vision calibration approach based on Elman neural network is proposed to approximate this complex model, and learn its nonlinear spatial mapping relationship implicitly. Moreover, in the process of modeling, the Levenberg-Marquardt (LM) algorithm (Martin 1994) is utilized to overcome some drawbacks of Elman neural network, such as: stucking in local shallow minima, and help the model slide through local minima and converge faster.

The proposed calibration approach works as follows:

1. According to the collected left and right images, the image coordinates of feature points in left and right images are extracted as input features of the Elman neural network, and then the LM algorithm is applied to train it with the training samples.
2. For the mathematical model of the Elman neural network, obtain the predictive value $\hat{p}$.
3. According to the LM algorithm, we define a performance index E (Equation 1), and adjust the weights until it reaches the minima or satisfies performance index (Equation 4, Equation 5), where the parameter μ is multiplied by some factor (β) when the performance index E increase, and μ is divided by β when the performance index E decrease.
4. Finally, for each point of targets, according to its image coordinates in left and right images, its corresponding 3D world coordinates are given by the trained Elman neural network.

$$E = \frac{1}{2}\sum_{q=1}^{Q}(\hat{p}_q - p_q)^2 = \frac{1}{2}\sum_{q=1}^{Q} e_q{}^2 \tag{1}$$

$$e_q = \hat{p}_q - p_q \tag{2}$$

$$\mathbf{e}(\mathbf{w}) = \left[e_1, e_2, \ldots, e_Q\right] \tag{3}$$

$$\mathbf{w}(t+1) = \mathbf{w}(t) + \Delta\mathbf{w}(t) \tag{4}$$

$$\Delta\mathbf{w}(t) = \left[\mathbf{J}^T(\mathbf{w})\mathbf{J}(\mathbf{w}) + \mu\mathbf{I}\right]^{-1}\mathbf{J}^T(\mathbf{w})\mathbf{e}(\mathbf{w}) \tag{5}$$

$$\mathbf{J}(w) = \begin{bmatrix} \frac{\partial e_1(\mathbf{w})}{w_1} & \cdots & \frac{\partial e_1(\mathbf{w})}{w_N} \\ \vdots & \vdots & \vdots \\ \frac{\partial e_Q(\mathbf{w})}{w_1} & \cdots & \frac{\partial e_Q(\mathbf{w})}{w_N} \end{bmatrix} \tag{6}$$

Here, $\hat{p}_q$ denotes the output value of neural network for the qth sample; p_q denotes the true value for the qth sample; e_q denotes the error of the qth sample; Q denotes the total number of training samples; $\boldsymbol{w}$ denotes the weights; N denotes the length of $\boldsymbol{w}$; $\mathbf{J}(w)$ denotes the jacobian matrix.

4 EXPERIMENTAL RESULTS

To evaluate the performance of the proposed approach, we test the approach with some real collected datasets and compare with other approaches.

Experimental installment and dataset extraction: In the experiments, two TaiDian L300 A cameras are used to capture images whose resolution is 640 * 480. A planar checkerboard with 7 * 9 grids (the size of each grid is 28 mm * 28 mm) (Fig. 2) is used to gather the calibration point samples. The distance between two cameras and the base line (z axis, z = 0) sets as 740 mm; the distance between two cameras sets as 455 mm; the angle between two cameras sets as about 45°. The planar checkerboard moves to 310 mm, 150 mm, 0 mm, –310 mm and –465 mm five locations along the z axis of a know reference frame to generate five images for each camera respectively. The upper left corner point is supposed as the origin of world coordinates, and the calibration points are gathered by calculating the grid corresponding coordinates in the images. Only 48 corner points in central part of each image are applied to calibrate stereo vision. Three datasets of 310 mm, 0 mm and –465 mm locations which consist of 144 pairs of points are utilized to train each neural network, while two

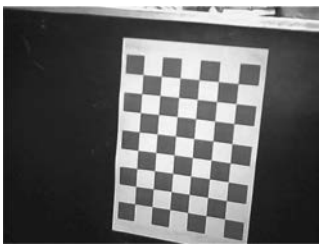

Figure 2. The planar checkerboard.

datasets of 150 mm and –310 mm locations which include 96 pairs of points are applied to test these neural networks.

The proposed approach is compared with other three approaches: BP neural network approach (Xing 2007), RBF neural network approach (Ge 2008) and GMDH neural network (Chen 2012). For parameter setting, RBF neural network approach adopts $4 \times 8 \times 3$ network structure, gauss kernel basic function and gradient descent learning rule; BP neural network approach adopts $4 \times 5 \times 5 \times 3$ network structure, LM learning rule and sigmoid basic function for hidden layer and linear basic function for output layer; GMDH neural network approach adopts second-order for basic polynomial function; the proposed approach adopts: $4 \times 4 \times 3 \times 3$ structure, LM learning rule and sigmoid basic function for hidden layer and linear basic function for output layer.

In order to evaluate the stereo vision calibration results objectively and quantitatively, the Root Mean Square Error (RMSE) (Ahmed 1999) and the Relative Root Mean Square Error (RRMSE) (Jekabsons 2010) are adopted to evaluate each approach. While the RMSE indicator assesses the global accuracy and stability, the RRMSE indicator assesses the accuracy and stability in individual dimension. Both lower values of RMSE and RRMSE indicators indicate a better calibration performance.

$$\mathrm{RMSE} = \sqrt{\frac{\sum_{i=1}^{n}\left[(x_i - \hat{x}_i)^2 + (y_i - \hat{y}_i)^2 + (z_i - \hat{z}_i)^2\right]}{n}} \tag{7}$$

$$\mathrm{RRMSE}(c) = \frac{RMSE(c)}{\mathrm{var}(c)},\ c = x \text{ or } y \text{ or } z \tag{8}$$

Here, $(\hat{x}_i, \hat{y}_i, \hat{z}_i)$ denotes the estimated world coordinates which is calculated by calibration approach; (x_i, y_i, z_i) denotes the true world coordinates; RMSE(c) denotes the individual RMSE indicator in dimension c; var(c) denotes the variance in individual dimension c which indicates the complexity of datasets.

The quantitative calibration results of four approaches across train and test datasets are shown in Tables 1 and 2 respectively. From these tables, we can see that: the BP and GMDH approaches perform well for train dataset, but relatively poor for test dataset; RBF approach performs relatively poor in both global and individual dimensions for train and test datasets; In contrast, the proposed approach has both lower RMSE and RRMSE indicators, and is very stable.

Table 1. The comparison of calibration results between four approaches for train data.

Calibration approach	RMSE	RRMSE (X)	RRMSE (Y)	RRMSE (Z)
BP	0.9806	0.0036	0.0042	0.0029
RBF	35.8273	0.1319	0.1034	0.1082
GMDH	1.0090	0.0072	0.0055	0.0027
Elman	0.9434	0.0047	0.0046	0.0027

Table 2. The comparison of calibration results between four approaches for test data.

Calibration approach	RMSE	RRMSE (X)	RRMSE (Y)	RRMSE (Z)
BP	19.122	0.0081	0.0238	0.0616
RBF	33.4	0.1061	0.0917	0.1045
GMDH	2.9158	0.0119	0.0359	0.0072
Elman	2.2235	0.0176	0.0332	0.0035

To sum up, some quantitative experimental comparisons are presented, and the results demonstrate that the proposed approach has both lower RMSE and RRMSE indicators, and performs very stable. It is capable of calibrating stereo vision effectively.

5 CONCLUSIONS AND DISCUSSION

We present a novel stereo vision calibration approach based on Elman neural network. The proposed approach introduces Levenberg-Marquardt algorithm to build spatial mapping relationship adaptively. It does not rely on any prior knowledge. The quantitative experimental comparisons demonstrate that the proposed approach is capable of calibrating stereo vision more accurately and is stable.

In the implementation of the proposed approach, we do not take account of the processing speed. To further improve calibration performance, we are going to study how to speed the model up in the future.

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Compressed sensing algorithms for direction-of-arrival estimation with nonuniform linear arrays

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ABSTRACT: The paper addresses the problem of Direction-of-Arrival (DOA) estimation with Nonuniform Linear Arrays (NLA), and proposes several Compressed Sensing (CS) algorithms to solve the problem. These algorithms are proposed based on CS method and the traditional DOA estimation algorithms. In the proposed algorithms, the CS method is used to recover the data of a Virtual Uniform Linear Array (VULA) from the data of a NLA, and the traditional DOA estimation algorithms are applied on the recovery data to estimate DOA. The experiments show the good efficiency of the proposed algorithms, especially of the CS-MUSIC and CS-RMUSIC algorithms.

Keywords: direction of arrival; compressed sensing; nonuniform linear array; orthogonal matching pursuit

1 INTRODUCTION

In the array signal processing, Uniform Linear Array (ULA) is very important and has extensive applications. However, in practice, some sensors of ULA may stop working, or the sensors cannot be uniformly spaced due to the complex acquisition conditions. Moreover, people often want to get good results with low cost. These cases yield the design of Nonuniform Linear Arrays (NLA) and algorithms for DOA estimation with NLA. For all designs of NLA, the Minimum Redundancy (MR) arrays and the Nonredundant (NR) arrays are well known (Moffet 1968, Vertatschitsch & Haykin 1986). Except the MUSIC and RMUSIC (root-MUSIC) algorithms, the traditional algorithms for DOA estimation are almost based on the ULA. Many algorithms, such as BF and ESPRIT, cannot be directly applied into the data of NLA (El Kassis et al. 2010). So many works have been done to obtain the data of a Virtual Uniform Linear Array (VULA) from the data of a NLA, such as (El Kassis et al. 2007).

A developing theory called Compressed Sensing (CS) can recover the sparse signal from incomplete and inaccurate measurements (Candes et al. 2006). The CS theory has been applied into DOA estimation with ULA (Gurbuz et al. 2012). Compared with the data of the corresponding VULA, the data of a NLA is incomplete and inaccurate. Therefore, we can apply the CS method into estimating DOA with NLA. In this paper, we use the CS method to recover the data of VULA from the data of NLA, and then apply several traditional DOA estimation algorithms on the recovery data to estimate the true DOA. We call these proposed algorithms the CS algorithms, including CS-BF, CS-MUSIC, CS-RMUSIC, CS-ESPRIT algorithms, and so on. The experiments show that the proposed algorithms are efficient, especially the CS-MUSIC and CS-RMUSIC algorithms.

The remainder of this paper is organized as follows. The preliminary knowledge is introduced in Section 2, the CS algorithms for DOA estimation with NLA is proposed in Section 3, the experiment results are reported in Section 4, and finally the conclusion is given in Section 5.

2 PRELIMINARY KNOWLEDGE

2.1 *Signal model with NLA*

Throughout the paper, we consider a NLA $[d_1 = 1, d_2, ..., d_M]$ $\lambda/2$ $(M < d_M)$ and L far-field incoherent narrowband sources impinging on the NLA come from distinct directions $\theta = (\theta_1, \theta_2, ..., \theta_L)^T$. where λ denotes the wavelength of the source signal and

the superscript T represents the transpose. Then the received signal at time t of the NLA takes the form

$$x(t) = A(\theta)s(t) + n(t), \tag{1}$$

where the $M \times 1$ vector $x(t)$ represents the received signal, the $M \times L$ matrix $A(\theta) = [a(\theta_1), a(\theta_2), ..., a(\theta_L)]$ is the array manifold matrix, the $M \times 1$ vectors $a(\theta_i) = [1, e^{-j\pi(d2-1)\sin\theta i}, ..., e^{-j\pi(dM-1)\sin\theta i}]^T$ $(1 \le i \le L)$ are the steering vectors, the $L \times 1$ vector $s(t) = [s_1(t), s_2(t), ..., s_L(t)]^T$ is the source vector, and $n(t)$ denotes a complex additive white Gaussian noise vector.

A VULA corresponding to the NLA is an ULA of d_M sensors, and the received signal at time t of the VULA can be expressed as

$$x_v(t) = A_v(\theta)s(t) + n_v(t), \tag{2}$$

where the $d_M \times 1$ vector $x_v(t)$ represents the signals of VULA, the $d_M \times L$ matrix $A_v(\theta) = [a_v(\theta_1), a_v(\theta_2), ..., a_v(\theta_L)]$ is the array manifold matrix, the $d_M \times 1$ vectors $a_v(\theta_i) = [1, e^{-j\pi\sin\theta i}, ..., e^{-j\pi(dM-1)\sin\theta i}]^T$ $(1 \le i \le L)$ are the steering vectors, and $n_v(t)$ also denotes a complex additive white Gaussian noise vector.

Suppose a $M \times d_M$ matrix G, whose entries are zeros and ones, satisfy

$$A(\theta) = GA_v(\theta). \tag{3}$$

Similar to the array interpolation technique (Weiss & Garish 1991), which aims to estimate the data of VULA from a NLA, the matrix G can be obtained by using

$$G = A(\theta)A_v(\theta)^H \left(A_v(\theta)A_v(\theta)^H\right)^{-1}, \tag{4}$$

where the superscript H denotes conjugate transpose.

Inserting (3) into (1), we have

$$x(t) = GA_v(\theta)s(t) + n(t). \tag{5}$$

2.2 *Compressed sensing*

A vector is called sparse if the number of its nonzero entries is much less than its length. Furthermore, a vector with length N is called k-sparse ($k << N$) if the number of its nonzero entries is not larger than k. CS theory is introduced to recover the sparse signal from compressed measurements which can result in significant reduction in the sampling (much less than Nyquist-sampling rate) and computational cost (Candes et al. 2006, Donoho 2006).

Suppose the vector signal $y = (y_1, y_2, ..., y_N)^T$ is sparse in the $\Psi \in C^{N \times N}$ domain, the representation is $y = \Psi Y$, and the vector Y is k-sparse. Suppose the signal y is measured by a $P \times N$ ($P << N$) matrix Φ, and the measurement signal is denoted by $y_m = \Phi y = \Phi\Psi Y$. The sensing matrix is defined by $A = \Phi\Psi$, so $y_m = AY$. The sparse noisy signal recovery problem can be formulated as

$$\min_{Y \in \mathbb{C}^N} \| Y \|_0 \; s.t. \| y_m - AY \| \le \varepsilon, \tag{6}$$

where $\varepsilon > 0$ is a bound on the magnitude of the error.

The above optimization problem can be solved with OMP algorithm (Tropp & Gilbert 2007) and other sparse recovery algorithms (Tropp & Wright 2010).

Furthermore, the sparse noisy signal recovery problem can also be formulated as the following convex optimization problem

$$\min_{Y \in \mathbb{C}^N} \| Y \|_1 \; s.t. \| y_m - AY \| \le \varepsilon, \tag{7}$$

which can be solved by the basic pursuit (BP) algorithms (Donoho & Tsaig 2006).

In order to recover the signal with high probability, it requires that the sensing matrix A obeys Restricted Isometry Property (RIP) (Candes & Wakin 2008). That is, for all k-sparse signal x and some constant $\delta_k \in (0, 1)$, the matrix A satisfy the following inequations

$$(1 - \delta_k) \| x \|_2^2 \le \| Ax \|_2^2 \le (1 + \delta_k) \| x \|_2^2 . \tag{8}$$

The RIP of the matrix $A = \Phi\Psi$ is related to the coherence of (Φ, Ψ), which is defined by

$$\mu(\Phi, \Psi) = \sqrt{N} * \max_{1 \le k < j \le N} |\langle \varphi_k, \psi_j \rangle|, \tag{9}$$

where ϕ_k is the normal k-th row of Φ, and ψ_j is the normal j-th column of Ψ. Observe that $\mu(\Phi, \Psi) \in [1, \sqrt{N}]$ (Candes & Wakin 2008). Reference (Baraniuk 2007) pointed out that both the RIP of A and incoherence of (Φ, Ψ) can be achieved with high probability simply by selecting measurement matrix as a random matrix. Therefore, we can illustrate the RIP of A by illustrating the incoherence of (Φ, Ψ).

2.3 *The traditional algorithms for DOA estimation*

There are many algorithms for DOA estimation, such as BF, MUSIC, RMUSIC, ESPRIT, and so on. References (Krim & Viberg 1996, Van Veen & Buckley 1988) have given a good summary for these algorithms, and the reader is referred to them for more details.

3 CS ALGORITHMS FOR DOA ESTIMATION WITH NLA

As mentioned in subsection 2.2, we know that two processes, representing and measuring, corresponding to the representation matrix Ψ and measurement matrix Φ respectively, are very important in the CS method. Then in order to apply the CS method into DOA estimation with NLA, we should design Ψ and Φ firstly. For DOA estimation, the received signal is sparse in angular domain (Malioutov et al. 2005). A natural idea for designing Ψ is to expand the manifold matrix $A_v(\theta)$ on an angular grid formed by uniformly sampling $2N$ points in the angular interval $(-\pi/2, \pi/2]$ and define Ψ as

$$\Psi = \frac{1}{\sqrt{d_M}}[a(\varphi_1), a(\varphi_2), \ldots, a(\varphi_{2N})], \tag{10}$$

where the steering vectors $a(\varphi_i) = [1, e^{-j\pi\sin\phi i}, \ldots, e^{-j\pi(dM-1)\sin\varphi i}]^T$ $(1 \le i \le 2N)$ and the coefficient $1/\sqrt{d_M}$ is used for normalizing the columns $a(\varphi_i)$, where $\varphi_i = (i - N)\pi/2N$. If the grid is fine enough to include the true DOAs, the steering matrix $A_v(\theta)$ can be represented by

$$A_v(\theta) = \Psi X, \tag{11}$$

Where X is a $2N \times L$ matrix, which is L-jointly sparse. Specifically, only the rows corresponding to the true DOAs are nonzeroes, and the other rows are zeroes. Combining (2), (5) and (11), we have

$$x_v(t) = \Psi X s(t) + n_v(t). \tag{12}$$

Obviously Xs is L-sparse, and hence the signal x_v is L-sparse in the Ψ domain.

In the CS theory, it is better that the representation matrix has the orthonormal or approximate orthonormal property. The following proposition illustrates that the matrix Ψ has the approximate orthonormal property.

Proposition 1. The representation matrix Ψ like (10) has the approximate orthonormal property.

Proof. We prove the approximate orthonormal property of Ψ like (10) by proving that the matrix $|\Psi^H\Psi|$ approximates the identical matrix. We consider the entries $|\Psi^H\Psi|_{n,l}$ $(1 \le n, l \le 2N)$ of the matrix $\Psi^H\Psi$

$$|\Psi^H\Psi|_{n,l} = \frac{1}{M}\left|1 + e^{i\pi\left[\cos\left(\frac{n\pi}{2N}\right)-\cos\left(\frac{l\pi}{2N}\right)\right]} + \cdots + e^{i\pi(M-1)\left[\cos\left(\frac{n\pi}{2N}\right)-\cos\left(\frac{l\pi}{2N}\right)\right]}\right|. \tag{13}$$

Observe that for any real number x and y, $e^{i\pi x} = \cos(x) + i\sin(x)$ and $\cos(x) - \cos(y) = -2\sin[(x+y)/2]\sin[(x-y)/2]$ both hold. We define the matrix Γ whose entries $\Gamma_{n,l} = \cos(n\pi/2N) - \cos(l\pi/2N)$. Then (13) can be simplified as

$$|\Psi^H\Psi|_{n,l} = \frac{|1 - e^{i\pi M\Gamma_{n,l}}|}{M|1 - e^{i\pi\Gamma_{n,l}}|} = \frac{1}{M}\left|\frac{\sin\left(\pi M\frac{\Gamma_{n,l}}{2}\right)}{\sin\left(\pi\frac{\Gamma_{n,l}}{2}\right)}\right|. \tag{14}$$

Because $|\Gamma_{n,l}| < 2$, only when $\Gamma_{n,l} = 0$ (i.e. $n = l$), we have $|\Psi^H\Psi|_{n,l} = 1$. When $0 < |\Gamma_{n,l}| < 2$ $(n \ne l)$, we have $\lim_{M\to\infty}|\Psi^H\Psi|_{n,l} = 0$. However, M is always finite in practice, and then when $\Gamma_{n,l} \approx 0$ or $\Gamma_{n,l} \approx 2$, $|\Psi^H\Psi|_{n,l} \approx 1$ holds. Consequently, the approximate orthonormal property of Ψ holds.

Therefore, the representation matrix Ψ not only ensures the sparsity of the received signals but also has approximate orthonormal property, i.e. the representation matrix Ψ is well designed.

In the following, we will design the measurement matrix Φ. Firstly, we introduce the random sub-sampling matrix $\bar{\Phi}_{m\times M}$ $(m < M)$, which randomly selects m rows out of a matrix with M rows. Define $\Phi = \bar{\Phi}\ G$, and it is easy to know that Φ is also a random sub-sampling matrix, which is used to select m sensors from the NLA.

In this paper, we will design the random sub-sampling matrix like $\Phi = \bar{\Phi}\ G$ as the measurement matrix. As mentioned in subsection 2.2, we would better design Φ which is incoherent with Ψ, and proposition 2 will prove it in the following.

Proposition 2. Suppose the matrix Φ is any random sub-sampling matrix, and Ψ is the representation matrix like (10), the coherence of (Φ, Ψ) is 1.

Proof. Suppose φ_k is the k-th normalized row of Φ, the entries of vector φ_k $(1 \le k \le m)$ including $M - 1$ zeroes and a single one, and ψ_i is the j-th column of Ψ. From (9), the coherence of (Φ, Ψ) is

$$\begin{aligned}\mu(\Phi,\Psi) &= \sqrt{M}\max_{1\le k\le M, 1\le j\le 2N}|\langle\varphi_k, \psi_j\rangle| \\ &= \sqrt{M}\max_{1\le l\le M, 1\le j\le 2N}\left|\frac{1}{\sqrt{M}}e^{j\pi(l-1)\sin\varphi_j}\right| \\ &= 1.\end{aligned} \tag{15}$$

Therefore the proposition 2 holds.

From proposition 2, we know that the random sub-sampling matrix $\Phi = \bar{\Phi}\ G$ and a representation matrix Ψ like (10) have the maximum incoherence. Then the matrices $\Phi = \bar{\Phi}\ G$ are well designed as the measurement matrices. Reference (Candes & Wakin 2008) pointed out that when the coherence is 1, we do not need more than $L\log d_M$ samples, but we cannot do with fewer either.

In summary, the CS model for recovering the signal $x_v(t)$ from the measurement vector

$$x_m(t) = \Phi x(t) = \bar{\Phi} G \Psi X s(t) + \bar{\Phi} n(t) \triangleq A y(t) + N(t), \quad (16)$$

can be established as the following optimization problem

$$\min \|y\|_0 \quad s.t. \ \|x_m - A y\| \le \varepsilon, \quad (17)$$

where $y = Xs$, $A = \Phi\Psi$ and $N = \bar{\Phi}\, n$.

We can obtain the recovery signal $\bar{X}_v = \Psi y$ by solving the problem (17) with the OMP algorithm or other sparse recovery algorithms, and then apply any traditional DOA estimation algorithm on the recovery data $\bar{X}_v$ to estimate DOA. Specifically, applying RMUSIC algorithm to $\bar{X}_v$ yields CS-RMUSIC algorithm, applying ESPRIT algorithm to $\bar{X}_v$ yields CS-ESPRIT algorithm. Similarly, we can obtain other CS algorithms for DOA estimation, such as CS-BF and CS-MUSIC, and so on.

The procedure of the proposed CS algorithms for DOA estimation with NLA can be summarized as follows:

Step 1. According to the configuration of the NLA, form a matrix G using (4);
Step 2. Construct a representation matrix Ψ like (10) and a measurement matrix Φ of the CS model;
Step 3. Recover the data of the VULA at time t by solving the problem (17) with some sparse recovery algorithms (such as OMP algorithm).
Step 4. Apply any traditional DOA algorithm on the recovery data to estimate DOA.

4 EXPERIMENT RESULTS

In this section, we give three experiments for DOA estimation with NLA using the proposed CS algorithms. We consider L incoherent narrowband far-field sources imping on a NLA of M sensors. The angular space $(-\pi/2, \pi/2]$ is divided into $2N = 180$ possible angles equally. Because the coherence between any random sub-sampling matrix and the represent matrix Ψ is 1 from proposition 2, the measurement number in each CS algorithm takes about $L\log d_M$. We sample 500 points in the temporal domain, and the results are averaged over 100 Monte-Carlo runs for each CS algorithm. OMP is used to solve problem (17) in the experiments. In the proposed CS algorithms, CS-BF and CS-MUSIC are spectral searching algorithms, and their results are illustrated in the figures; whereas other proposed CS algorithms are search-free algorithms, and their results are illustrated in the tables. The results are compared with EM-ESPRIT (El Kassis et al. 2007) and "BF with VULA", where "BF with VULA" means applying the BF algorithm to the ideal noiseless signals of VULA. The results for EM-ESPRIT algorithm are based on 500 trials in each case, and the maximum number of iterations in EM-ESPRIT algorithm is 30 (El Kassis et al. 2007). The ESPRIT algorithm used in the experiments is the least square ESPRIT (LS-ESPRIT) algorithm.

Example 1. Suppose a NLA d = [1, 3, 6] $\lambda/2$ of M = 3 sensors, a single signal comes from the direction of 10°. In this example, we consider four cases of the signal received by NLA: noiseless, SNR = 20 db, SNR = 10 db and SNR = 0 db. In this example, the measurement number $m = 2 \approx \log 6$ in each CS algorithm. The results of EM-ESPRIT, CS-ESPRIT and CS-RMUSIC algorithms are listed in Table 1, and the results of CS-BF and CS-MUSIC algorithms in the case of SNR = 10 db are shown in Figure 1.

From Table 1, we find that the EM-ESPRIT algorithm is efficient, but the error is large even though SNR is high. For the same recovery data from the data of NLA, the CS-ESPRIT algorithm cannot well estimate DOA when SNR is low, whereas the CS-RMUSIC algorithm always performs very well. From Figure 1, CS-BF and CS-MUSIC algorithms both perform well when SNR = 10db.

From the results of Example 1, we find that EM-ESPRIT and CS-ESPRIT algorithms perform poor when SNR is low; the reason is that LS-ESPRIT is biased when the data are noisy (El Kassis et al. 2007). Then we will not consider EM-ESPRIT and CS-ESPRIT more in the following two examples.

Table 1. Results of CS-RMUSIC algorithm for example 1.

Angle/deg.	Noiseless	SNR = 20 db	SNR = 10 db	SNR = 0 db
EM-ESPRIT	10.2828	10.2668	10.1334	8.7928
CS-ESPRIT	10.0000	9.9866	9.9686	2.0227
CS-RMUSIC	10.0000	9.9955	10.0274	9.5720

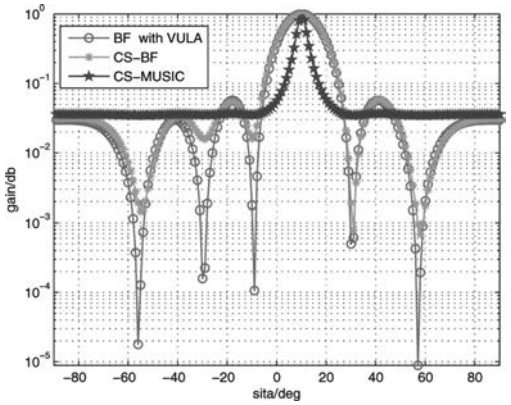

Figure 1. The spatial spectrum of the CS-BF and CS-MUSIC algorithms when SNR = 10 db for example 1.

Table 2. Results of CS-RMUSIC algorithm for example 2.

Angle/deg.	SNR = 20 db	SNR = 10 db	SNR = 0 db
CS-RMUSIC	–14.9862	–14.9403	–14.7684
CS-RMUSIC	10.0184	10.0374	9.6645

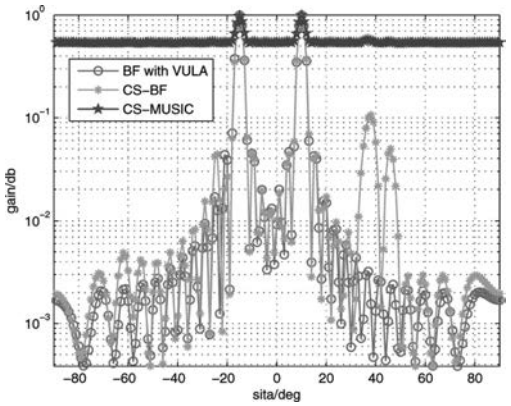

Figure 2. The spatial spectrum of the CS-BF and CS-MUSIC algorithms when SNR = 10db for Example 2.

Example 2. Suppose the NLA is a MR array of 9 sensors, that is, the NLA is $d = [1, 2, 3, 15, 19, 22, 25, 28, 30]\ \lambda/2$. Two signals come from the directions of (–15°, 10°). In this example, we consider three cases of the received signal by NLA: SNR = 20 db, SNR = 10 db and SNR = 0 db, and takes the measurement number $m = 7 \approx 2\log 30$ in each CS algorithm. The results of the CS-RMUSIC algorithm are listed in Table 2, and the results of CS-BF and CS-MUSIC algorithms in the case of SNR = 10db are shown in Figure 2.

Table 3. Results of CS-RMUSIC algorithm for example 3.

Angle/deg.	SNR = 20 db	SNR = 10 db	SNR = 0 db
CS-RMUSIC	–14.9996	–14.9403	–15.4048
CS-RMUSIC	9.9808	10.0210	10.3140

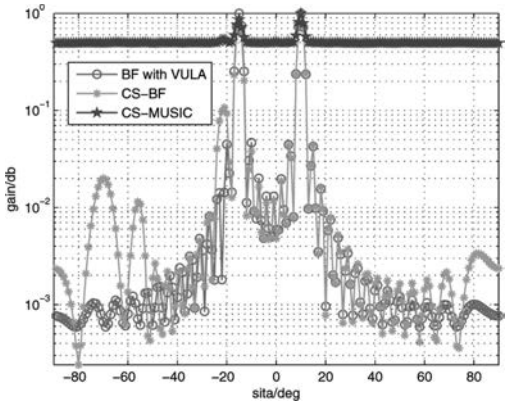

Figure 3. The spatial spectrum of the CS-BF and CS-MUSIC algorithms when SNR = 10db for Example 3.

Example 3. Suppose the NLA is a NR array of 8 sensors, that is, the NLA is $d = [1, 2, 5, 10, 16, 23, 33, 35]\ \lambda/2$. Two signals come from the directions of (–15°, 10°). In this example, we also consider three cases of the received signal by NLA: SNR = 20 db, SNR = 10 db and SNR = 0 db, and takes the measurement number $m = 7 \approx 2\log 35$ in each CS algorithm. The results of the CS-RMUSIC algorithm are listed in Table 3, and the results of CS-BF and CS-MUSIC algorithms in the case of SNR = 10 db are shown in Figure 3.

From the results of examples 2 and 3, we find that CS-BF, CS-MUSIC and CS-RMUSIC algorithms perform well for estimating DOA with NLA, especially the CS-MUSIC and CS-RMUSIC algorithms.

5 CONCLUSION

With the developing CS method, we have proposed a novel model and several CS algorithms for DOA estimation with NLA. These algorithms firstly recover the data of corresponding VULA from the received data of NLA, and then apply any traditional DOA estimation algorithm on the recovery data to estimate DOA. The example results show that the proposed CS algorithms are efficient, especially the CS-RMUSIC and CS-MUSIC algorithms.

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An improved particle swarm algorithm for distribution network reconfiguration

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ABSTRACT: PSO algorithm is one a kind. But PSO is easy to be prematurity and fall into local optimization. So this paper provides an particle swarm optimization algorithm based on the organizational evolutionary (OEPSO). The evolutional operations are acted on organizations directly in the algorithm, and gained the global convergence ends through competition and cooperation, and overcome the shortcomings of the traditional PSO. Based on analysis of the distribution network reconfiguration model and the traits of OEPSO, the mathematical model and the procedures for solving the optimized distribution network optimization by using OEPSO were proposed in detail. A case study about American PG&E network system indicates that OEPSO has better convergence speed and computational accuracy, whereby providing a novel effective method or way for the settlement of the problem of distribution network reconfiguration.

Keywords: particle swarm optimization; organization; evolutionary computation; unconstrained optimization; distribution network reconfiguration

1 INTRODUCTION

Particle Swarm Optimization (J. Kennedy et al., 1995) was come up with Kennedy and Eberhartin 1995. The main method to resolve this problem is to gain the size of particle swarm, which there is some change in calculated performance, but there is also some lack: first, this method can not overcome the problem of premature convergence radically; second, this method will gain the calculated amount of algorithm. In case to this lack, many improved PSO algorithm is come out, for example Shi Yuhui and Eberhart (Shi Y et al., 2001) proposed a faintness PSO; according to the circumgyration stretch method combined with PSO algorithm change the form of the objective function, a global optimization algorithm was proposed by Konstantions Parsopolos, A et al.,); Ratnaweera (Ratnaweera, A et al.,) introduced time-varying acceleration constant and put forward variant time-varying particle swarm algorithm, self-organization hierarchical time-varying particle swarm algorithm and so on.

From the perspective of organization, this article composite different tissues by the individual form, makes full use of inter-organization individual collaboration characteristic and self-study characteristics, puts forward organizational evolutionary particle swarm algorithm. The algorithm thinks about the general particle memory characteristics, self-organizational of competition and mutual cooperation, so the particles can better adapt to the environment, guide the particle swarm evolution and achieve the goal of global optimization ultimately. In order to make full research the algorithm property, the algorithm is tested by twelve unconstrained standard of tested function, compared with three kinds of particle swarm algorithm and fast evolutionary programming algorithm (Yao X et al.,) and the algorithm used in the parameters to the algorithm performance is analyzed. The results show that the algorithm for function optimization is effective.

2 EASE OF USE PARTICLE SWARM ALGORITHM BASED ON ORGANIZATIONAL EVOLUTIONARY

2.1 *Particle swarm algorithm*

Considering the global optimization problem

$$\min\left\{f(x): x \in \Omega \subset R^n\right\},\ f, \Omega \subset R^n \tag{1}$$

The potential answer of optimization problem is regarded as a particle in the search space without mass and volume. It has certain flight speed and position, represented in ordered three-dimensional (x^i, v^i, h). Among them, $x^i(t) = (x_1^i, x_2^i, \ldots, x_n^i)^T$ is the ith current location of particle, $v^i(t) = (v_1^i, v_2^i, \ldots, v_n^i)^T$ is the ith current speed of particle, $h^i(t) = (h_1^i, h_2^i, \ldots, h_n^i)^T$ is the ith best location of particle by self-experience, n is the search space dimension. Make all the particles which experienced the global best position is $h^g(t) = (h_1^g, h_2^g, \ldots, h_n^g)^T$, t is evolutionary iterative algebra, so the speed and position updating formula of the particle in t+1 generation is:

$$\begin{cases} v_j^i(t+1) = v_j^i(t) + c_1 r_1 (h_j^i(t) - x_j^i(t)) + c_2 r_2 (h_j^g(t) - x_j^i(t)) \\ x_j^i(t+1) = x_j^i(t) + v_j^i(t+1) \end{cases} \quad (2)$$

where c_1 and c_2 are acceleration constants, r_1 and r_2 are obey uniform distribution of random variables in [0, 1] range. From the velocity update can be seen, the constant c1 particle was adjusted to itself through the optimal position of flight of the maximum amplitude, constant c2 particle was adjusted to the global best particle maximum range flight. In addition, for preventing the particles go out of the search space, its speed VI is often limited by a maximum speed $V_{\max}$. The first part of speed update formula express particle previous speed in type (2); the second part is "cognition", which express thinking of particles themselves; the third part is "social", which express the information sharing and cooperation between particles (Van den Bergh, F).

2.2 *Particle swarm algorithm based on organizational evolutionary*

In this paper, the individual uses real vector representation, we only consider the minimization problem, so the individual fitness is defined as: organization is some collection of individual, these individual are known as the member of organization, the best fitness of member is organization leader. If an organization has multiple members with the same optimal value and randomly selected one as a leader. The fitness of leader is the fitness of organization, the intersection of different organization is empty. Here are four applied to the particle swarm algorithm for organizational evolutionary operator.

2.2.1 *Design of particle swarm algorithm for organizational evolution*

1. Splitting operator

In this operator, the condition to split organization org is:

$$|\text{org}| > \text{Max} \quad (3)$$

where |org| express the number of org member, $Max_{os}(< N_0)$ express allowed the max number of members, N_0 is the number of all the organization members in initialized. Max_{os} and N_0 both are preset parameter. If a father organization org satisfy (3), it will be divided into two sub organization, org_{c1} and org_{c2}: in org_i we randomly select $|org_i|/3:2|org_i|/3$ member to compose the sub organization org_{c1}, the other members compose the sub organization org_{c2}. Then form the current population to delete organization org_i, and the organization of org_{c1} and org_{c2} joined to the next generation of evolutionary population.

2. Annexation operator

Two father organization are $org_{i1} = \{x^1, x^2, \ldots, x^{m_1}\}$ and $org_{i2} = \{y^1, y^2, \ldots, y^{m_2}\}, m_1$ is the number of organization org_{i1} member, m_2 is the number of organization org_{i2} member, and $F(org_{i1}) \geq F(org_{i2})$, so use org_{i1} to annex org_{i2} to produce a new sub organization $org_c = \{z^1, z^2, \ldots, z^{m_1+m_2}\}$, where $z^i = x^i, i = 1,2,\ldots,m_1$. If $U_{j+m_1}(0,1) < AS, j = 1,2,\ldots,m_2, z^{j+m_1}$ will be produced by annexation strategy 1, otherwise it will be produced by annexation strategy 2. Here the subscript representation of $U_{j+m_1}(0,1)$ expresses to produce a random number for each $j + m_1, AS \in (0,1)$ is preset parameter. The two annexation strategy is respectively given by (4) and (5).

To set the leader of org_{i1} is $(a_1, a_2, \ldots, a_n)$, the new one is $r_j = (r_{j,1}, r_{j,2}, \ldots, r_{j,n})$, $j = 1,2,\ldots,m_2$. So in the annexation strategy 1, r_j is produced by (4):

$$r_{j,k} = \begin{cases} \underline{x}_k & d_{j,k} < \underline{x}_k \\ \overline{x}_k & d_{j,k} > \overline{x}_k \\ d_{j,k} & \text{otherwize} \end{cases} \qquad k = 1, 2, \ldots, n \quad (4)$$

where, $d_{j,k} = a_k + U_k(0,1) \times (a_k - y_k^j)$.

In annexation strategy 2, r_j is produced by (5):

$$r_{j,k} = \begin{cases} \underline{x}_k + \beta_k \times (\overline{x}_k - \underline{x}_k) & U_k(0,1) < 1/n \\ a_k & \text{otherwize} \end{cases} \quad k = 1,2,\ldots,n \quad (5)$$

where $\beta_k = U(0,1)$ and it is different to each x^k.

After r_j is calculated, z^{j+m_1} is determined by (6):

$$z^{j+m1} = \begin{cases} r_j & F(r_j) \geq F(y^j) \\ r_j & F(r_j) < F(y^j) \text{ and} \\ & \{U_j(0,1) < \exp(F(r_j) - F(y^j))\} \\ y^j & \text{otherwize} \end{cases} \quad (6)$$

In fact, annexation strategy 1 is a kind of heuristic crossover operator; annexation strategy 2 is a kind of mutation operator. From the type (6)

we can see when the fitness of r_j is better than y^j,r_j will progress the fitness of organization by entering org_c. When the fitness of r_j is worse than y^j,r_j will enter org_c probability, namely the fitness of r_j is more close to y^j, the more greater, this helps to keep the population diversity. Finally, from the current population we delete org_{i1} and org_{i2}, and let org_c join to the next population.

3. Cooperation operator

Let two father generation organization as $org_{i1} = \{x^1, x^2, \ldots, x^{m_1}\}$ and $org_{i2} = \{y^1, y^2, \ldots, y^{m_2}\}$. If $U(0,1) < CS$, two offspring organization org_{c1} and org_{c2} are produced by cooperation strategy 1, otherwise produced by cooperation strategy 2, here $CS \in (0,1)$ is preset parameter, two cooperation strategy are given by type (12) and (13).

Let the leader of org_{i1} as $(a_1, a_2, \ldots, a_n)$, the leader of org_{i2} as $(b_1, b_2, \ldots, b_n)$, two new individuals which are produce by cooperation are $u = (u_1, u_2, \ldots, u_n)$ and $l = (l_1, l_2, \ldots, l_n)$, so in the cooperation strategy 2, u and l are produced by (7).

$$\begin{cases} u_k = \beta_k \times a_k + (1-\beta_k) \times b_k \\ l_k = (1-\beta_k) \times a_k + \beta_k \times b_k \end{cases} \quad k = 1,2,\ldots,n \tag{7}$$

where, $\beta_k = U(0,1)$.

In cooperation strategy 2, u and l are produced by (8), where $1 < i_1 < n, 1 < i_2 < n$, and $i_1 < i_2$.

$$\begin{cases} u = (a_1, a_2, \ldots, a_{i_1-1},\ b_{i_1}, b_{i_1+1}, \ldots, b_{i_2},\ a_{i_2+1}, a_{i_2+2}, \ldots, a_n) \\ l = (b_1, b_2, \ldots, b_{i_1-1},\ a_{i_1}, a_{i_1+1}, \ldots, a_{i_2},\ b_{i_2+1}, b_{i_2+2}, \ldots, b_n) \end{cases} \tag{8}$$

After u and l produce, org_{c1} and org_{c2} are respectively determined by type (9) and (10):

$$org_{c1} = \begin{cases} \{x^1, x^2, \ldots, x^{i-1}, u, x^{i+1}, \ldots, x^{m1}\} \\ \qquad \exists x_i \in org_{i1}, \quad F(x^i) < F(u) \\ org_{i1} \qquad \text{otherwize} \end{cases} \tag{9}$$

$$org_{c2} = \begin{cases} \{y^1, y^2, \ldots, y^{j-1}, l, y^{j+1}, \ldots, y^{m2}\} \\ \qquad \exists y_j \in org_{i2}, \quad F(y^j) < F(l) \\ org_{i2} \qquad \text{otherwize} \end{cases} \tag{10}$$

Finally from the current population delete org_{i1} and org_{i2}, and let org_{c1} and org_{i2} join to the next population. In fact, cooperation strategy is arithmetic crossover, cooperation strategy 2 is a kind of disrete crossover operator.

4. Speed renewal operator

Let be $h^g(t) = (h_1^g, h_2^g, \cdots, h_n^g)^T$ expresses the best leader experience over its location in all organization, $h^i(t) = (h_1^i, h_2^i, \cdots, h_n^i)^T$ expresses the ith organization for experience its best location, so the ith tissues of particle are updated in the 2th of speed and location as follows:

$$\begin{cases} v_j^i(t+1) = w(t)v_j^i(t) + c_1 r_1 (h_j^i(t) - x_j^i(t)) + c_2 r_2 (h_j^g(t) - x_j^i(t)) \\ x_j^i(t+1) = x_j^i(t) + v_j^i(t+1) \end{cases} \tag{11}$$

Speed and location vector are updated by using inertia weight method.

2.2.2 *Particle swarm algorithm for organizational evolutionary description*

Algorithm 2: particle swarm algorithm for organizational evolutionary

Step 1: Initialize population Q_t with N_0 organization and every organization only have one particle, set t ← 0;

Step 2: If the condition is satisfied, then output the result and stop the operation; otherwise, return Step 3;

Step 3: Each organization in Q_t, if splitting condition is satisfied, then executive splitting operator;

Step 4: If the number of organization in Q_t is larger than 1, then return Step 5, otherwise return Step 6;

Step 5: From Q_t randomly to select two father generation organization orgi1 and orgi2, then randomly select annexation operator or cooperation operator to function in those two father generation organization, return Step 4;

Step 6: Surplus organization in Q_t join in Q_t +1;

Step 7: update the speed and location of particle, set t ← t+1, return Step 2.

3 DISTRIBUTION NETWORK RECONFIGURATION PROBLEM

According to the operating conditions, distribution network are reconfigured for three purposes: (1) reconfiguration for loss minimization, (2) reconfiguration for load balancing, and (3) reconfiguration for service restoration. In this sense, the efficient operation of distribution network can be achieved by modifying the open/closed status of the different switches in order to transfer load from heavily loaded feeders and substation transformers to relatively less heavily loaded feeders and transformers. By reducing the level of loads on feeders and substation transformers the power losses are reduced and the voltage profile along the feeders is improved. Therefore, the Distribution Network Reconfiguration (DNR) problem can be conceptualized like the task of identify a new configuration with minimal power losses, while all the system constraints are satisfied.

This is a combinatorial optimization problem where the aim is to determine the open/closed status of all switches in order to obtain an optimum configuration in a large scale distribution system.

In this paper, loss minimization is considered as the objective. The DNR problem is described as below:

3.1 *Objective function*

In this paper the objective function for the DNR is to minimize the power losses, which can be calculated as follows:

$$\min f_{ploss} = \sum_{i=1}^{L_1} k_i r_i \frac{P_i^2 + Q_i^2}{V_i^2} \tag{12}$$

where L_1 is the number of the branches. k_i is the state of ith tie switch (0 = open, 1 = close). r_i is the resistance of line section i. P_i and Q_i are the net injected active and reactive powers at the ith bus. V_i is the voltage magnitude of bus i.

3.2 *Main restriction conditions*

1. Power flow restriction

$$\sum_{k=1}^{n} Sub_k = \sum_{j=1}^{m} Load_j + \sum_{i=1}^{L} Loss_i \tag{13}$$

where Sub_k is the complex power of substation k. $Load_j$ is the load of node j. $Loss_i$ is the power loss of bus i. n is the number of substation. m is the number of node.

2. Capacity restriction

$$I_l \le I_{\max,l} \qquad l = 1,2,...,L_2 \tag{14}$$

where I_l is the current of element l. $I_{\max,l}$ is the maximum current of the lth element. L_2 is the number of element.

3. Voltage restriction

$$V_{\max,j} \le V_j \le V_{\min,j} \qquad j = 1,2,...,m \tag{15}$$

where V_j is the voltage of node j,$V_{\max,j}$ and $V_{\min,j}$ are the maximum voltage and minimum voltage of node j, respectively.

4. Radical distribution network restriction

$$g \in G \tag{16}$$

where g is the present distribution network. G is the admissible radial network configuration of all.

4 APPLICATION OF OEPSO TO DISTRIBUTION NETWORK RECONFIGURATION

In order to validate the possibility and reliability of the OEPSO algorithm, OEPSO was used to solve the American PG&E distribution network reconfiguration problem. Figure 1 shows the American PG&E distribution system.

American PG&E distribution network have 69 nodes, 73 branches and 5 tie switches: nodes (11&66), (13&20), (15&69), (27&54), (39&48). The rated voltage is 12.66 KV, the total load is 3802.19+j2694.6 KVA.

With Pentium IV 2.0CPU and 512M memory hardware and Delphi6 + MS SQL Server software circumstance, PSO algorithm and OEPSO algorithm are used to solve the DNR problem with American PG&E distribution system. The distribution results by PSO and OEPSO algorithms are show in Table 1.

It is seen that before reconfiguration,the initial losses and minimum voltage in per unit are 225.712 and 0.9052 KW, respectively. After reconfiguration, 6 tie switches has changed and the OEPSO

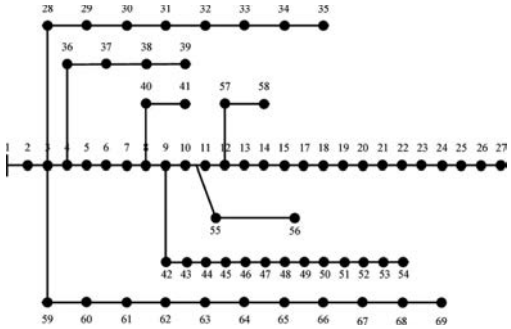

Figure 1. American PG&E distribution system.

Table 1. Result before and after reconfiguration of 69-node.

Comparative index	Base system	PSO	OEPSO
Open line sections	11–66	11–66	11–66
	13–20	13–20	13–20
	15–69	14–15	14–15
	27–54	44–45	47–48
	39–48	50–51	25–26
Power losses (KW)	225.712	100.810	100.696
Minimum voltage (pu)	0.897	0.933	0.933
Generations		300	28
CPU time (s)		57.3	1.42

algorithm give the global optimum configuration. The comparison results between the PSO and OEPSO show that the power loss of the OEPSO is a little less than PSO, but the generations and executions time of OEPSO are significantly short in respect with PSO and provides a general idea. In other words, OEPSO reaches a better optimal solution compared with PSO. All of the comparative index prove that the OEPSO is an better algorithm than PSO, which has stability of global optimization and a higher speed of calculation.

5 CONCLUSIONS

Combining the fast optimization function of PSO algorithm and the global optimization function of SA algorithm, OEPSO algorithm is presented and introduced into distribution network reconfiguration problem. The solution of distribution network reconfiguration problem based on it is put forward too. It is testified by theory and practice that the algorithm can escape from partial optimal problem PSO faced, then the reliability of global optimization is greatly promoted, which offers a new way to solve the distribution network reconfiguration optimal problem.

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The legal risk rating for food enterprise based on artificial neural networks

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ABSTRACT: Strengthening legal risk management by rating the legal risk for food enterprise, will play a great role in food enterprises' internal self-discipline and avoid the occurrence of food safety crisis. BP artificial neural network has self-adaptive function of fault tolerance and error correction, which can make identification and rectification to the chaos of food enterprise legal risk under high uncertainly environment and evaluate the legal risk for food enterprise precisely. This paper chooses 20 food enterprises in Changsha City as sample, and establish artificial neural network rating model for food enterprise legal risk.

Keywords: food enterprise; artificial neural network; legal risk

1 INTRODUCTION

The earliest study about risk and its management is in BC. Today, risk and its management theories are more and more mature. But the studies about legal risk and its management research started at the beginning of this century, which is still a hot research up to now. Crouhy (2005) attributed the legal risk together with market risk, credit risk and liquidity risk into the bank risk to manage. Xiang & Chen (2006) carried preliminary discussion on the enterprise legal risk assessment, introduced risk value method and risk income method into legal risk rating, and proposed the risk of default method.

Artificial neural network research began in the 1940s. In 1943, The Psychologists McCulloch & the mathematicians Pitts (1943) first proposed MP model. Hebb (1949) put forward the Hebb learning role after summarizing the research achievements of conditioned reflex in 1944. After more than ten years, Rosenblatt (1986) presented the theory of perceptron and put the artificial neural network research to a climax. Hopfield (1982) gave the stability criterion using HNN mode, and explored new ways for associative memory and optimization calculation in the 1980s. Hinton and Sejnowski (1986) presented Boltzman model, which using the learning method of multi-layer network to ensure that the system as a whole tend to be the globally stable point. Rumelhart & Hinton (1986) proposed the PDP theory, which developed the multilayer network of BP algorithm and became the most common network up to now. Kosko (1986) presented bidirectional associative memory network for learning. HechtNielsen (1989) introduced back propagation network model which can be used for image compression and statistical analysis. Chua (1990) proposed cellular neural networks model, which as a large-scale nonlinear analog system and make the artificial neural network research on a new step. Some domestic scholars applied artificial neural network to the credit risk assessment, but there has no literature for applying them to enterprise legal risk assessment.

Once the food safety events occurrences, for the consumers, will harm their healthy and influence their physical quality, for the food enterprises, will make them face to the legal risk loss. Therefore, strengthening the legal risk management will play an important role in food enterprises' internal self-discipline and avoid the occurrence of food safety crisis. The legal risk rating is the key for legal risk management of food enterprises.

2 ESTABLISH THE LEGAL RISK EVALUATING INDEX SYSTEM FOR FOOD ENTERPRISE

Lay In the current research literature for company legal risk management, the legal risk evaluating index system for companies has not been put forward, but the factors which will make the companies exist general (overall) legal risk has been studied preliminarily. Lovells international law

firm issued the report of legal risk for China top 100 companies in 2005, said that they make industries, organization form, the place which companies set up, intellectual property, procurement and sale behaviors (foreign) as the risk factors for risk assessment. The legal risk evaluating factors which have listed by Xiang-fei and Chen-youchun are similar to the Lovells', including the Legal environment factors, the jurisdiction area, the organization form of legal entity, business model, industry factor, the intellectual property rights, and the place of management behavior, etc.

However, the general (overall) legal risk factors of companies are mainly two types, which are the external environmental factors and internal law behavior factors. The external environmental factors mainly include legislative environment, judicial environment and law enforcement environment. The internal law behavior factors are mainly include enterprise organization form, scope of business and the legal risk management mechanism. The classification framework is in Figure 1 as follows.

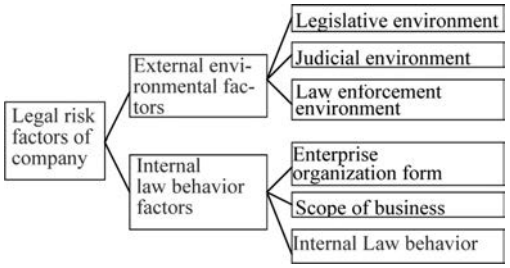

Figure 1. The tree diagram of legal risk factors of companies.

3 DETERMINE AND STANDARDIZE THE SAMPLE FACTOR VALUES FOR FOOD ENTERPRISE LEGAL RISK RATING

The samples of this study are from Changsha city (including six areas and three counties), which have 20 food enterprises, including 6 primary food production companies of agriculture, forestry, animal husbandry, sideline occupations and fishery, and 7 high processed food enterprises, 3 catering companies, and 4 rough machining food enterprises.

Due to the company legal risk index is difficult to be expressed directly in quantitative, we take the expert scoring method to quantize. The first step is dividing the grading standard of all input factors as follows.

Enterprise organization form = (Senior, Medium, Simple) = (5,3,1),

Scope of business = (Complex, Medium, Simple) = (5,3,1),

Table 1. The factor values of legal risk for the 20 food enterprises.

Company number	Enterprise organization form	Scope of business	Internal law behavior	Legislative environment	Judicial environment	Law enforcement environment
1	4.1	4.5	2.8	4.3	3.2	4.8
2	4.5	2.8	2.5	2.8	4.1	4.2
3	4.0	4.8	4.6	3.5	4.2	3.6
4	5.0	2.9	3.2	2.6	2.7	4.1
5	2.2	3.7	1.8	2.9	3.9	3.9
6	5.0	4.0	4.1	4.8	4.7	2.7
7	5.0	5.0	3.8	3.9	4.3	4.5
8	4.2	4.8	3.7	4.7	4.0	4.2
9	4.3	2.5	4.5	3.1	4.7	1.8
10	4.1	1.7	4.6	2.7	3.9	2.7
11	3.5	3.9	4.0	1.7	2.4	4.6
12	2.2	4.5	3.5	5.0	4.5	3.1
13	1.8	1.4	3.0	2.6	3.6	2.7
14	4.8	4.2	4.7	4.6	3.8	4.9
15	2.5	3.2	2.6	4.2	3.4	3.0
16	3.8	3.5	4.1	4.1	1.6	5.0
17	4.6	2.9	4.3	4.0	4.7	4.7
18	3.8	4.5	3.8	4.8	4.1	2.8
19	1.8	4.0	4.3	4.7	4.3	3.4
20	2.9	3.8	3.9	3.3	3.6	2.6

Table 2. The standard factor values of legal risk for 20 companies.

Company number	Enterprise organization form	Scope of business	Internal law behavior	Legislative environment	Judicial environment	Law enforcement environment
1	0.82	0.90	0.56	0.86	0.64	0.96
2	0.90	0.56	0.50	0.56	0.82	0.84
3	0.80	0.96	0.92	0.70	0.84	0.72
4	1.00	0.58	0.64	0.52	0.54	0.82
5	0.44	0.74	0.36	0.58	0.78	0.78
6	1.00	0.80	0.82	0.96	0.94	0.54
7	1.00	1.00	0.76	0.78	0.86	0.90
8	0.84	0.96	0.74	0.94	0.80	0.84
9	0.86	0.50	0.90	0.62	0.94	0.36
10	0.82	0.34	0.92	0.54	0.78	0.54
11	0.70	0.78	0.80	0.34	0.48	0.92
12	0.44	0.90	0.70	1.00	0.90	0.62
13	0.36	0.28	0.60	0.52	0.72	0.54
14	0.96	0.84	0.94	0.92	0.76	0.98
15	0.50	0.64	0.52	0.84	0.68	0.60
16	0.76	0.70	0.82	0.82	0.32	1.00
17	0.92	0.58	0.86	0.80	0.94	0.94
18	0.76	0.90	0.76	0.96	0.82	0.56
19	0.36	0.80	0.86	0.94	0.86	0.68
20	0.58	0.76	0.78	0.66	0.72	0.52

Internal Law behavior = (Not perfect, Medium, Perfect) = (5,3,1),

Legislative environment = (Unstable, Medium, Stable) = (5,3,1),

Judicial environment = (Strict, Medium, Loose) = (5,3,1),

Law enforcement environment = (Bad, Medium, Well) = (5,3,1)

The second step is determining the factor values according to the mean value of all experts, the legal risk factor values of the 20 companies are shown in Table 1.

We use linear scaling transformation method to standardize the factor values of company legal risk rating. Divide each value by the highest score of 5, and standardize the rating matrix, we have the data as Table 2.

4 CONSTRUCT ARTIFICIAL NEURAL NETWORK MODEL FOR THE LEGAL RISK EVALUATING OF FOOD ENTERPRISES

Because the food enterprise legal risk rating indexes have 6 items, we set the BP neural network inputs unit number as 6, i.e. the 6 standard data are the unit number for input layers, which are shown in Table 2. The unit number for output is 1 item, i.e. the values of company legal risk rating. For the hidden layer, the more, the more complex for the process of error backward propagation, and the training time will greatly increase. Moreover, while the hidden layer increasing, the local minimum error will increase. In addition, how to select the unit number for hidden layer is also a technical question. Selecting too more, will increase the training time and make the network handle too much messages, including some meaningless message. Selecting too less, will reduce the tolerance of the network and can't get ideal result for some complex problems. We set the unit number of hidden layer is 5 for rating the company legal risk. Finally, the selection of initial values for learning convergence effect is significant, which require each neuron status value near to 0 when add up the initial weights, where the right is a random value between [–1, 1], generally. We select the learning factor is a = 0.1. So, we construct the BP artificial neural network for the food enterprise legal risk rating as Figure 2.

In the BP artificial neural network model, each neural layer satisfying the following conditions:

$$Z_j = f\left(\sum_{i=1}^{6} W_{ij} X_i - \theta_j\right), Y_t = f\left(\sum_{j=1}^{5} V_{jt} Z_j - \gamma_t\right) \quad (1)$$

where $f(u) = 1/(1+e^{-u})$, which function graph is shown in Figure 3.

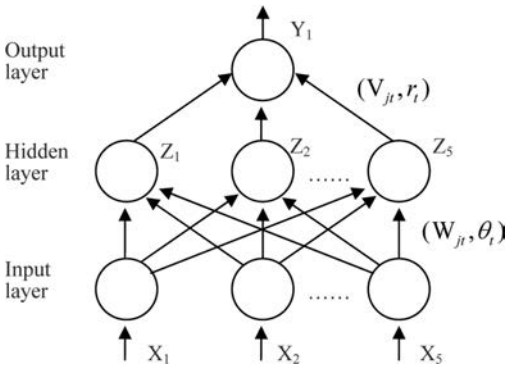

Figure 2. The BP artificial neural network for the food enterprises legal risk.

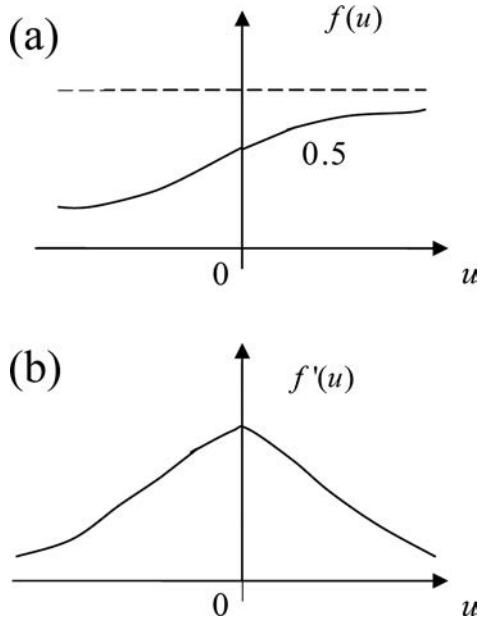

Figure 3. (a) Sigmoid impact function, (b) The derivative curve of (a).

5 THE TRAINING FOR NEURAL NETWORK MODEL AND THE RATING OF THE FOOD ENTERPRISE LEGAL RISK

By the computer simulations, training the number 1–10 company legal risk rating, we get the evaluating results as Table 3.

According to the data in Table 3, the neural network training values are near to the expected values of experts, and the training can be finished.

Table 3. The training results of the neural network for food enterprise legal risk rating.

Training results of the neural network			The expected values of experts		
No.	Training result	Grade	No.	Training result	Grade
1	0.7825	3	1	0.73	5
2	0.7159	7	2	0.69	7
3	0.8920	1	3	0.81	1
4	0.7342	6	4	0.67	8
5	0.7016	8	5	0.62	10
6	0.7722	4	6	0.75	4
7	0.7653	5	7	0.79	2
8	0.8010	2	8	0.77	3
9	0.6583	10	9	0.70	6
10	0.6800	9	10	0.65	9

Table 4. The rating results of the company legal risk.

No.	Rating result	Grade	No.	Rating result	Grade
11	0.7258	7	16	0.8342	4
12	0.8134	5	17	0.8520	3
13	0.4720	10	18	0.8723	1
14	0.8656	2	19	0.7452	6
15	0.7005	9	20	0.7254	8

Using the neural network training values, we make the rating for the number 11–20 companies by the BP artificial neural network model and get the results as Table 4.

Rating the company legal risk by BP artificial neural network model not only provides the premise for the company legal risk managers to avoid, accept or select decisions, but also provides strong basis for the company legal risk managers to establish legal risk prevention and control mechanism.

6 CONCLUSIONS

In the case that the other evaluation methods are difficult to be applied in company legal risk rating, artificial neural network method plays more and more important role in the process of company legal risk rating.

Firstly, the factors of company legal risk are difficult to be expressed by using accurate data, which only can be given some general score by the expert scoring method with strongly subjectivity. While the method of BP artificial neural network make

learning and training by using the estimated values which are given by experts, and weaken subjective factors of data by the adaptive function in training process. So, we can get the optimal solution of the problem.

Secondly, company legal risk general is nonlinear, which is difficult to make decision by linear method. The method of BP artificial neural network provides effective means and ways to solve this nonlinear problem.

Thirdly, BP artificial neural network has self-adaptive function of fault tolerance and error correction, which can make identification and rectification to the chaos of food enterprise legal risk under high uncertainly environment and find out the developing role of company legal risk and provide right decisions for company risk managers.

Finally, BP artificial neural network as a kind of multi-objective legal risk decision-making method, not only can be used to rate the multiple food enterprise legal risk, but also can be used to select legal action plans of the multiple food enterprise, and can be used to analyze and study the legal risk factors of multiple food enterprise, which precisely meet the needs of the diversity and complexity of the company legal risk decisions.

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Adolescent attachment and the mobile phone addiction: Mediating effects of social support

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ABSTRACT: Objective: To examine social support as mediators of the relationship between adolescent attachment and mobile phone addiction tendency. Methods: Totally 891 adolescent students selected with cluster sampling were interviewed using Experiences in Close Relationships Inventory (ECR), the Mobile Phone Addiction Tendency Questionnaire (MPATS) and the Social Support Rating Scale (SSRS). Result: The testing of mediating effects showed that adolescent attachment had both direct and indirect effects on the mobile phone addiction tendency, with the direct effect as the main effect. Conclusion: Adolescent attachment has direct effects on individuals' mobile phone addiction, but also has indirect impacts through social support.

Keywords: adolescent attachment; mobile phone addiction; social support; mediating effects

1 GENERAL INTRODUCTION

There are more and more so-called "mobile phone families", "mobile phone parties", "mobile phone persons", "bow clans"and "electronic servants" among adolescent students, who are keen to read e-books, update twitters, chat by micro messages, play electronic games, do shopping, and so on. Recently, it was reported that mobile phone addiction perhaps has become a new trend of the internet addiction among adolescents.[1] Mobile phone addiction is a new phenomenon of human behavior after the internet addiction, and it is an obsessed state which is obviously damaged psychologically and physiologically by overusing mobile phones due to some kind of motivation.[2]

Mobile phone addiction has taken many negative influences to adolescent students, such as inducing physiological diseases, influencing their rest, sleep, relationships and learning efficiency at classroom, increasing economy burden, reducing comprehension and leading to some personality disorders.[3][4]

Attachment refers to a special emotional relationship in which people are close and attached to each other. Social support is a kind of behavior and information of carefulness and confidence which is collected by an individual from his or her social members, which directly reflects the extent and quality of an individual with his or her social relationships.[5] Attachment may have important regulation functions to shape, maintain, and use[6] Psychoanalytic theories suggests that addictive behavior is a manifestation of attachment disorders.[7] A research showed that the scarce of social supports might be one of the main reasons of behavior addictions among adolescent students.[8]

Mobile phone addiction has taken many scholars' and experts' concerns. At present, there are few studies on the relationship among the mobile phone addiction, attachment and social support. This study mainly discussed the relationship between the mobile phone addition and attachment, and whether social support is a mediator of the relationship between attachment and mobile phone addiction.

2 METHOD

2.1 *Participants*

Nine hundred students from two vocational colleges in Shandong province were recruited by stratified sampling. 900 questionnaires in total were circulated, of which 881 were returned (a response rate was 97.9%). Of the questionnaires returned 4 were blank and 877 were completed for adequate use in the study, hence resulting in 877 participants in this study (287 females, 590 males). Age ranged from 14 to 19 years with an average of 18.1 (SD = 1.6).

2.2 *Materials*

This study utilised the Experiences in Close Relationships Inventory (ECR), the Mobile Phone

Addiction Tendency Questionnaire (MPATS) and the Social Support Rating Scale (SSRS).

The Mobile Phone Addiction Tendency Scale (MPATS). The Mobile Phone Addiction Tendency Scale is a 16-item questionnaire, which was devised and validated as a reliable self-report by Xiong Jie, Zhou Zongkui, et al,[9] developed to measure the mobile phone addiction, including four factors: withdrawal symptoms, salience, social comfort and mood changes. Items are related on a 5- point scale. Higher scores indicate heavier mobile phone addiction. The cronbach's alpha of each item in the test ranged from 0.689 to 0.856, and the cronbach's alpha of the whole scale was 0.919, showing the high level of internal consistency and suggesting that items are homogenous.

The Experiences in Close Relationships Inventory (ECR).[10] The Experiences in Close Relationships Inventory is a 36-item questionnaire, which was designed to assess the attachment conditions of adolescent students, including attachment anxiety and attachment avoidance two factors. Items are related on a 7-point scale. Higher scores indicate higher anxiety of avoidance degree. The cronbach's alphas of the two factors were 0.727 and 0.886, and the cronbach's alpha of the whole scale was 0.794.

Social Support Rating Scale (SSRS).[11] The Social Support Rating Scale was designed to assess an individual's social supports from others, including four factors: the objective support of society, subjunctive support of society and the utilization extent of social support, with 10 items. The total score of the scale is the norm of social supports, higher score indicates more individual's social supports. The cronbach's alpha of the whole scale was 0.92, and the consistence of each item was from 0.89 to 0.94.

2.3 *Data analysis*

The total score for each questionnaire or scale was calculated by summing the scores of each item per participant. The statistical procedures used were the correlation analysis and the testing of mediating effects. The data were analyzed using SPSS (version 17.0). The levels of significance were 1% and 5%, respectively.

3 RESULTS

The correlation analysis about mobile phone addiction, social support and The relationships among the attachment, social support and mobile phone addiction were showed in Table 1.

As shown in Table 1, there was a significant negative correlation between the mobile phone addiction and social support. And there was a significant positive correlation between the attachment anxiety and mobile phone addiction. The attachment avoidance was significantly negatively correlated with social support. The attachment anxiety was significantly negatively correlated with social support and attachment avoidance. But there was no significant correlation between the mobile phone addiction and attachment avoidance ($P > 0.05$).

3.1 *The testing on the mediating effects of the social support between the attachment and mobile phone addiction*

In order to further examine the relationship mechanism between the attachment, social support and mobile phone addiction, we had a mediating effects test, taking attachment anxiety as independent variable (X), mobile phone addiction as the dependent variable (B), and the total score of the social support as the intermediate variable, according to the correlation results above and in accordance with the mediating effects test procedures proposed by Wen Zhonglin, Zhang Lei, et al[12] (Table 2). For the correlation between the attachment and attachment avoidance was not significant, we didn't consider the mediating effects test of the social support between the attachment and mobile phone addiction.

As shown in Table 2, the regression coefficient (mobile phone addiction tendency as dependent variable, and attachment anxiety as independent variable) was 0.469. But when the variable of social support was added into the regression, the

Table 1. Correlation of mobile phone addiction social support and attachment.

Item	Mobile phone addiction	Social support	Attachment avoidance	Attachment anxiety
Mobile phone addiction	1			
Social support	–0.149**	1		
Attachment avoidance	–0.010	–0.207**	1	
Attachment anxiety	0.469**	–0.139**	–0.075**	1

**Level of significance 0.01(two-tailed).

Table 2. Mediating effects of social support between attachment and mobile phone addiction.

Steps	Standardized regression equation	Test of regression coefficient
1	$Y = 0.469\ X$	SE = 0.022 t = 15.69**
2	$M = -0.139\ X$	SE = 0.063 t = –4.163**
3	$Y = -0.085\ M$	SE = 0.012 t = –2.842**
	$0.457\ X$	SE = 0.022 t = 15.205**

**Level of significance 0.01(two-tailed).

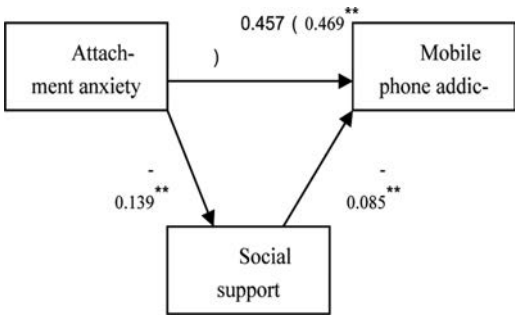

Figure 1. Path of the mediating effect model of social support.

regression coefficient reduced to 0.457, showing the social support has mediating effects between the attachment and mobile phone addiction. Attachment anxiety had direct influence on the mobile phone addiction, at the same time, had indirect influence on mobile phone addiction. The mediating effect took up 0.025 of the total effect.

The mediating effect model of the social support between attachment and mobile phone addiction is described in Figure 1.

4 DISCUSSION

The result showed that there was a significant positive correlation between the mobile phone and attachment anxiety factor. Fuendeling found that the individual with attachment anxiety is prone to notice and express their nerviness and emotion, through a lot of practical researches about attachment and emotion adjustment.[13] In order to loosen the nervous emotion, their notice would naturally turn to the use of mobile phone, so which will increase the mobile phone addiction tendency. Some studies showed there were close relationship between the mobile phone addiction and anxiety.[14]

The study found that the higher the social support score from others is, the lower the mobile phone addiction tendency among adolescent students. This is accordance with the former studies about the relationship between social support and behavior addictions. Wei Yaoyang pointed out in his study social support negatively correlated with mobile phone addiction,[15] but the correlation between the social support and mobile phone addiction is no significance ($r = -0.08$, $P > 0.05$). Because the studies about relationship between the mobile phone and social support are not so much, we then analyzed some studies about the relationship between the internet addiction and social support, found that there was significant negative correlation between them. Mobile phone addiction and internet addiction belong to the behavior addiction naturally, so this study also proved the scarce of social support is an important factor leading to behavior addictions.

The result of the mediating effect test showed social support played some mediating effect partly between the attachment and mobile phone addiction. That is to say, the attachment conditions not only influenced mobile phone directly, but also indirectly influenced the mobile phone addiction by social support. Social support as the evaluation or cognition about an individual's own social resources available is based on the relation conditions with the people around.[16] While the individual characteristic of the individual with attachment anxiety is afraid of being rejected or abandoned, the mobile phone with powerful functions and convenience provides a good platform for them. However, it is apt to cause mobile phone addiction if of a mobile phone is excessively abused, which will take many serious negative influences on their health, learning and life.[17] This study also proved that social support as a favorable protection factor, could help adolescent students ease their attachment anxiety; reduce the mobile phone addiction tendency directly and indirectly.

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Study on training approach for microsystem design and fabrication

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ABSTRACT: Microsystem technologies, which is the fundamental field that students should know, is a cutting-edge interdisciplinary leading humanity into the microcosm. Based on analysis on the course of Microsystem Design and Process, the course content, training approach, experimental methods are discussed. The tactics include appropriate choice of course contents, establishing of diversified teaching methods, strengthening of practice part. At the same time, communication platform for both teacher and student are set up to make full use of modern multimedia and Internet platforms and the diversity of assessment system is employed. The requirements on teachers are provided. The cultivation of students' innovative ability is discussed.

Keywords: reform in education; training approach; microsystem technology; MEMS

1 INTRODUCTION

Microsystem technology is an advanced interdisciplinary emerging, developed in recent twenty years [1]. It covers almost all fields of natural science and engineering technology, Including electronics, mechanical, materials, manufacturing, information and automatic control, physics, chemistry, biology and other disciplines, and associated with many sophisticated and intensive achievements of modern science and technology. It has extensive applications in information, communication, aviation, aerospace, automotive, medical, biological, environmental protection, industrial control and other areas [2,3]. Microsystem technologies will be one of the most influential high-tech in twenty-first century, and a new growth point of high-tech industry. It is considered a new industrial revolution in twenty-first century. The research in this field is developing rapidly during to enormous human and material resources in the main countries of the world. Investment of this field also increases in China, and many famous domestic universities also set up this course.

As an advanced emerging discipline, it is still in the initial stage of exploration from the aspects of course content, teaching methods, experimental practice. This paper attempts to explore from aspects above, so that the students can have a comprehensive understanding of the latest research achievements in the course characteristics as soon as possible, broadening the students' knowledge, mastering the basic theory of the field, which is to build good foundation in scientific research or engineering application. And the cultivation of students' innovation ability is also discussed.

2 CHARACTERISTICS OF THE COURSE

The early development of microsystem technologies, the meaning and technical characteristics of this area have various understandings for different people. The world's main countries in the world have their own naming according to their own development histories of the field. It is called Micromachine in Japan since their development thought is from large machining to small machinery, and to micro machine [4]. It is named Microelectromechanical System (MEMS) during to its development based on microelectronic fabrication technology in North America [5]. And it is called Microsystem Technologies for it is considered as system in Europe. What the name is not unified shows that the development of this field is still at an early stage of development. Despite the different names, but the contents are in convergence. It the early stages, named Micromachine is proper slightly due to from large machining to small machinery, and to micro machine; With nearly twenty years of development in this field, especially the mainstream processing is based on the microelectronics technology the, Moreover, its products are from a single separation part to the small system, some even a system of micro electro mechanical system, called micro machinery is inarticulate. Obviously, MEMS is worthy of the name; With the further research in this field, its product even is a complex system. It also comprises a light, sound and

other parts beside machine, electric parts. Called microsystem seems more appropriate, deserved.

3 DISCUSSION AND ANALYSIS OF THE CURRICULUM CONSTRUCTION

The construction of education and teaching in Colleges and universities is to implement the construction of three level discipline construction, specialty construction and curriculum construction. Among them, the curriculum construction is the foundation, the concrete implementation of discipline and specialty construction, the decisive factor to ensure the quality of teaching. The curriculum construction is an important part of the basic construction of school teaching. Strengthening the curriculum construction is the effective implementation of teaching plan, an important guarantee for improving the teaching level and the talent training quality. realization of students innovation ability and knowledge innovation system are based on the curriculum construction [6].

3.1 *Reasonable arrangements of the course content*

The course content is very complicated owing to characteristics of its interdisciplinary, and students involve multiple disciplines students in this course, but lesson hours are limited. Therefore, for the arrangement of teaching content, it is necessary to consider the multi disciplines. The main technologies in the field are Including microsystem design, micromachining technology, MEMS devices, microsystem integration and package. Among them, the microsystem design is the base of the subject. Micromachining technology is the key of the subject, and microsystem is available only to employing the micromachining technology. So, the two parts need to emphasize on. MEMS devices are mainly focus on the technical status of the field as well as the latest developments.

3.2 *Enriching the diversification of teaching method*

The rapid development of microsystem technologies in recent years, traditional teaching methods have been difficult to meet the needs of course teaching. It is important to establish a wide range of diversified teaching methods. Multimedia technology has enriched the course teaching, and the introduction of multimedia courseware and electronic teaching plan have brought great vitality to the teaching.

Moreover, the prospects about the latest microsystem technologies, the advanced technology application and development are through employing teaching animation and video to provide sound, images, graphics and other information. So that students will have intuitive understanding of perceptual on abstract and boring knowledge on principle and design, which greatly improve the students' participation desire and interest in learning.

In addition, because of time constraints, the contents that are not taught or explained in class can be discussed via the Internet web sites and/or discussion groups. The students who have a will to further understand and study may have way to extend their own knowledge via to set up communication channels and platforms.

3.3 *Strengthening the practice part*

The course of Microsystem Technologies is the one which has high requirement for practice and hands-on abilities. The practice teaching is an important means to cultivate students' innovation ability. This course is based on the existing conditions, and reasonably arranges for experimental teaching. The experiments are including photolithography, CVD, etching and other basic micromachining process. Students are arranged in group due to less equipment. Up to date, the students participate in discussing the overall scheme of experiment, and after the discussion and analysis on experimental plans, the students can deepen the understanding of the micromachining technologies.

3.4 *Listing and numberin implementing diversity assessment methods*

The curriculum performance evaluation system is the means and the guarantee to assess grasping the knowledge and ability evaluation of students. Reasonable evaluation system can make students free from examination oriented education mode and meet requirement to strengthen comprehensive ability of students. It is beneficial to the cultivation of innovative talents. Diversification of assessment means can in lead guides beneficial to cultivation for students' abilities in scientific logical thinking and problem solving. So that students may pay more attention to the cultivation of practical ability. Assessment system is including the assessment in class, homework, experiment and practice. For instance, Through writing a small paper in group, the comprehensive practical ability and the spirit of team work are trained. The score of the course is divided into the one of homework, small paper, experiment (practice) and test.

3.5 *Requirements on the quality of teachers*

Teachers are the implementers of curriculum construction and teaching reform. Since the field is

still at primary stage of development and an interdisciplinary subject, these make the theory system of the curriculum is not yet perfect and there is no mature theory system. Because of reasons above, the teachers' quality is put forward higher requirements. To properly complete the teaching task, the teacher should not only have good teaching ability and solid professional knowledge, but experience of scientific research on MEMS. Having sufficient knowing of the main content, the teachers have a clear understanding of the key technology of this field and have the ability to grasp the global field. So the teachers can make many ways appropriate choice of teaching content, and can do a good job with skill and ease in the teaching process.

4 CULTIVATION OF STUDENTS' INNOVATION ABILITY AND FORMATION OF INNOVATION KNOWLEDGE SYSTEM

Because we built the microsystem technologies lab which is an open lab, it has modeling, design and comprehensive experiments. students can enter the laboratory to participate in scientific research in their spare time, or take the class knowledge into practice.

Interested students can also expand their own ideas for college students' scientific and technological competition through the open laboratory. Those means can play an important role in cultivating students' innovation ability and can effectively promote the gradual formation of students' innovation system.

The practice means above can make students master the basic knowledge of course, and train students' independent thinking and self-learning ability. At the same time, teachers can know the learning effects, so that the ones can timely adjust course contents and teaching plan, and make the teaching more targeted.

In the specific implementation, we adopt a real case combined with my research experience, for example, modeling and micromachining process of microneedle array, the problems how the model is built and process arrange reasonably should be paid attention to. So the students can know of the real research work, understand cultivation for innovative ability and innovative thinking, enables the student to have the feeling of be personally on the scene.

5 CONCLUSION

As a new subject, it is very necessary for research on curriculum construction and practice of teaching method. This paper discusses on curriculum construction of the microsystem technologies and proposes some suggestions in course contents, teaching methods and experiment teaching. The cultivation of innovative talents is also discussed. In the implementation of teaching, the learning enthusiasm of the students is increased, and the teaching effect is improved obviously.

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Development of three-phase smart meter based on dual ATmega128L and its applications in power quality

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ABSTRACT: In order to solve the problems of distribution management and power quality improvement of large electricity users, a new design of three-phase smart meter based on dual high speed ATmega128L and Zigbee is proposed in this paper, and introduces its hardware interface circuit design and its applications in improving power quality, and its feasibility is verified by field test. High precision MAX125 and ATmega128L are used for data synchronous acquisition, calculation, analysis, display, SD card storage and results record, moreover, Zigbee is used for uploading data which are used for the upper system software to make power quality analysis, thus can strengthen electricity management of users, improve power quality and save energy. The instrument has advantages of easy portability, low cost, high precision, strong anti-interference ability and easy to promote, thus can effectively meet the needs of dedicated large users' power quality managements.

Keywords: power quality; comprehensive control; smart meter; dual ATmega128L; wireless communication technology of Zigbee; MAX125; Matlab

1 INTRODUCTION

China has implemented large-scale transformation and construction to the grid in recent years, thus cause a large number of dedicated users increase continuously, and strengthen the management of electricity enterprises.[1–6] The concepts of improving power quality and realizing the energy saving and consumption reducing is paid more and more attention, as a result, the multifunctional intelligent electric meters have been widespread attention and application.[7–13]

So, a portable three-phase smart electric meter based on dual AVR and ATmega128L is presented in this paper. The meter utilizes two ATmega128L MCUs as its control core and makes full use of their rich on-chip resources and peripheral equipment, thus can real-time monitor, record, display and large store big users' three phase voltage, current, active power, reactive power, apparent power, power factor and other electrical parameters which exist in low voltage side of users' distribution system, meanwhile, the use of Zigbee wireless communication mode[14] realizes that the measurement data are uploaded on time to the upper software and which makes real-time comprehensive power quality treatment analysis. The software is designed based on Matlab and according to China's power quality standards; it makes corresponding analysis with the data transmitted through Zigbee, and puts forward the improvement scheme, which can effectively improve the power quality of users. Through the laboratory environment test and field test of enterprise internal distribution system, the smart meter runs normally and its feasibility is verified. It proves that the smart meter conforms to the design requirements of current smart meter market, thus can effectively improve the efficiency and ability of distribution network power quality managements in enterprises. What's more, the three-phase multifunctional smart meter designed in this paper has advantages of low cost, strong intelligence, high measuring precision and easy to be popularized.

2 HARDWARE DESIGN

2.1 *Working principle of the system*

The working principle of the system is schematically shown in Figure 1.

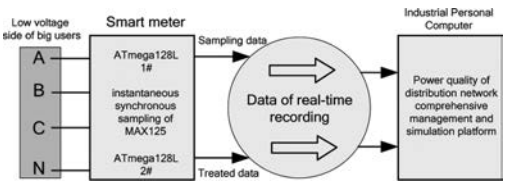

Figure 1. System principle and structure block diagram.

Smart meters put forward in this paper are connected to low voltage side of large users, three-phase voltage and current signal and zero phase voltage and current signal from big users' measuring lines are sampled in the way of instantaneous synchronous by the chip MAX125, and this data sampling process is controlled by 1# ATmega128L, such as real-time tracking frequency signal, synchronous A/D conversion control, voltage and current channel magnification control, and so on. 2# ATmega128L receives sampling data from 1# ATmega128L through SPI synchronous serial communication interface, then implements a series of calculations on these data. On one hand, these data are displayed by LCD module and stored by SD card; on the other hand, the Zigbee Control Module in the Zigbee wireless communication unit is controlled by 1# ATmega128L to receive and send data to the power quality comprehensive management and real-time simulation platform based on Matlab, and this platform utilizes the powerful data analysis functions of Matlab to implement effective distribution management and power quality improvement analysis on the big electricity dedicated users.

2.2 *Hardware structure desgin*

The structure of system is shown in Figure 2, the hardware system is mainly composed of frequency measurement signal conditioning circuit, voltage channel signal conditioning circuit, current channel signal conditioning circuit, high precision instantaneous A/D sampling circuit, dual AVR MCU signal processor, SPI bus, function display and handle unit (keys, real-time clock, temperature sensor, LCD display), oscillation circuit, SD control module, SD card, Zigbee control module, industrial personal computer and so on. Among which, the computer is arranged on the software of power quality comprehensive management and simulation platform, which is the core power quality analysis software of dual ATmega128L smart meter.

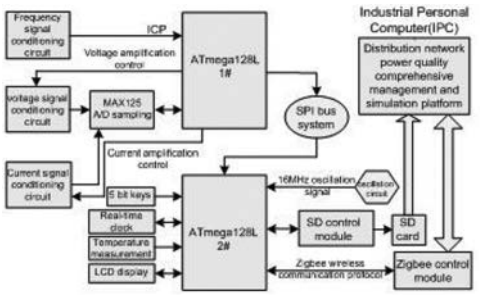

Figure 2. Structure of hardware system.

The voltage and current channel signal conditioning circuit are respectively composed of PT, CT, and programmable amplifying circuit, among them, PT uses voltage output type voltage converter TR1102-1C, CT uses voltage output type current converter TR1102-2C, two kinds of converters are connected to the voltage follower, which realizes impedance matching.

A/D sampling circuit utilizes high precision and fast AD sampling chip MAX125, this chip is 14 bits synchronous converter with 8 channels, and it has 8 Sample/Hold (S/H) circuits, which collect 8 channel analog signals each time, and under the S/H circuit, realizing ADC conversion, and the switching time of 8 channels is 3.7 s. The output of MAX125 is 14 bits digital signal DB0-DB13 which is transmitted to 1# AVR for further processing.

1# and 2# AVR are both use ATmega128L, this type MCU is as the core digital processor of smart meter designed in this paper has the following characteristics: low power consumption and high speed 8 bit MCU, 128 KB FLASH program memory, 4 KB RAM and 4 KB E^2PROM are integrated, and the E^2PROM is very suitable for parameter setting, and it doesn't lose data under power off. In addition, this chip also integrates with JTAG interface which is used for online simulation debugging and program download, thus is very convenient for program modification and upgrading online.

The functions of 1# and 2# are different, 1# AVR is mainly responsible for the four roads voltage and current signal amplification control, frequency tracking and synchronous AD conversion control, and in addition, it transmits the digital signal real-time to the 2# AVR through SPI bus. The SPI bus system is a synchronous serial peripheral interface, it can make the MCU and various peripheral devices communicate to exchange information in a serial manner, and it has a total of 3 registers: controlling register SPCR, status register SPSR and data register SPDR.

The 2# AVR utilizes its rich on-chip resources and peripheral instruments, can real-time monitor, record, display, communicate and large capacity store basic distribution network electrical parameters such as three-phase voltage, current, active power, reactive power, apparent power and power factor. Furthermore, it can calculate and obtain the maximum, minimum, and average value of these basic electrical parameters in a set time. The operation process of the smart meter is shown in Figure 3.

2.3 *Design of dual ATmega128L inner main program and sampling program*

The program of lower-computer is written in C language, and is finally written into the ATmega128L

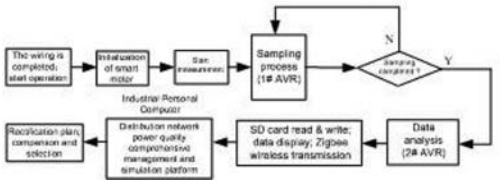

Figure 3. Smart meter application flow chart.

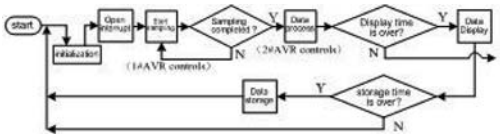

Figure 4. Main program flow chart.

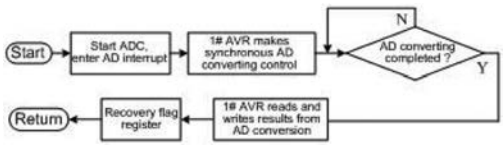

Figure 5. Sampling program flow chart.

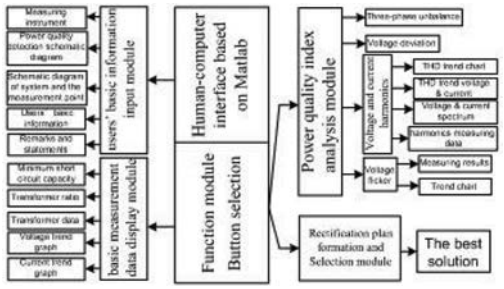

Figure 6. Structure of main computer software.

Flash. The main program and sampling program flowchart of smart meter is respectively shown in Figure 4 and Figure 5.

2.4 *Design of distribution network power quality comprehensive management and simulation platform based on Matlab/Simulink*

The distribution network power quality comprehensive management and simulation software is based on Matlab/Simulink and written in C language. This simulation platform constitutes the upper computer system software, and is composed of 4 parts, such as users' basic information input module, basic measurement data display module, power quality index analysis module, rectification plan formation and selection module. A comprehensive analysis of the upper computer system software outputs the final power quality rectification report of users. Its structure is shown in Figure 6.

3 EFFECT OF APPLICATION IN PRACTICAL ENGINEERING

3.1 *Measuring results*

Field measurements were conducted in a cement production enterprise in Shaoguan city of China, the basic situation of the factory is: two 35 kV lines, of which the voltage is stepped down 6 kV through 2 sets of S7-8000/35 main transformers; another 6 kV branch transports to the mine substation. I segment and II segment 6 kV lines are stepped down 380/220 V through two level variation, and used for low voltage equipment. The system and measurement points are shown in Figure 7 and Table 1.

Due to space limitations, only make a detailed analysis on measurement point 1 (3#3). Basic load situation is shown in Table 2, and based on which, the software of power quality analysis obtains the statistical graphs of users' power quality index, including the voltage deviation detection results (shown in Table 3), the A phase voltage and current total harmonic distortion and harmonic spectrum (including the maximum, minimum, average, 95% probability spectrum) (respectively shown in Figures 8 and 9), the voltage unbalance detection results (shown in Table 4), the voltage fluctuation detection results (shown in Table 5), and the voltage flicker detection results (shown in Table 6).

3.2 *Rectification solutions*

Aim at the power quality problems shown from the testing results above, three solutions are presented as following.

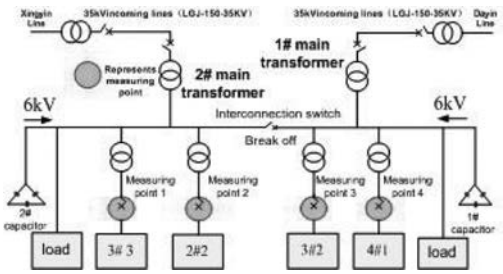

Figure 7. Schematic diagram of scale measurement points.

Table 1. Transformer data of the measuring point.

Transformer number	Capacity (kVA)	Type	Impedance (%)	Connection group
3#3	1250	S7-1250/6	4.5	Y,yn0
3#2	630	S7-630/6	4.5	Y,yn0
4#1	1250	S7-1250/6	4.5	Y,yn0
2#2	1600	S9-M-1600/6	4.65	D,yn11

Table 2. Basic load situation of measuring point no. 1.

Power relevance	Maximum value	Minimum value	Average value	95% value
Voltage (V)				
Phase A	235.710	208.000	226.897	232.520
Phase B	236.890	210.410	229.135	234.160
Phase C	239.430	212.430	229.977	234.820
Current (A)				
Phase A	12.000	3.000	4.570	6.000
Phase B	2623.000	627.000	1100.939	1400.000
Phase C	2454.000	556.000	999.731	1275.000
Apparent power (kVA)				
Phase A	538.350	137.500	292.567	397.750
Phase B	553.800	145.700	305.191	413.500
Phase C	522.900	129.300	279.942	382.000
Active power (kW)				
Phase A	407.000	94.000	244.863	329.000
Phase B	429.100	102.000	258.944	347.300
Phase C	384.900	85.800	230.782	310.700
Power factor				
Phase A	0.99	0.97	0.98	–
Phase B	0.99	0.97	0.99	–
Phase C	0.99	0.97	0.99	–

Table 3. Voltage deviation of measuring point no. 1.

Voltage deviation (%)	Maximum (%)	Minimum (%)	Average (%)	International value (%)	Qualified rate (%)	Qualified
Phase A	***7.270***	***–2.324***	***3.417***	*(**–10, +7**)*	***99.618***	***FLASE***
Phase B	***7.767***	***–1.080***	***4.437***	*(**–10, +7**)*	***98.438***	***FLASE***
Phase C	***8.396***	***–0.396***	***4.821***	*(**–10, +7**)*	***93.993***	***FLASE***

*Note: bold italics indicate that the type of data does not meet Chinese Industrial Standards (CIS).

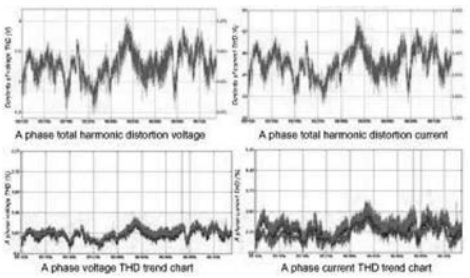

Figure 8. Voltage and current harmonic THD of A phase.

Solution 1: install capacitors and passive filter.

In order to filter harmonic currents, multiple groups of passive filter can be installed. Aim at higher harmonic content in load current, and the main characteristics of harmonic current are generated as 3, 5, 7, 11, 13 times, thus can install 3, 5, 7, 11, 13 times single tuned filter. In order to filter high times harmonic, a group of high pass filter can be installed, and the cutoff frequency selected as 15 times.

Solution 2: install STATCOM and hybrid active power filter.

Install a STATCOM device can effectively improve the voltage flicker and voltage deviation

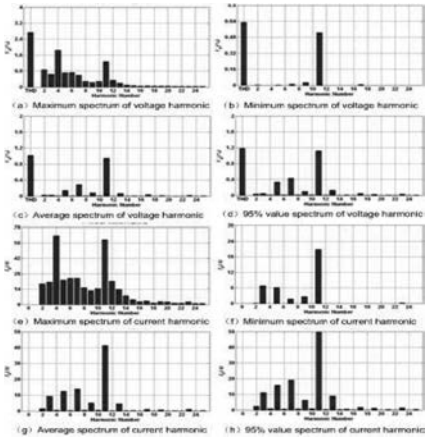

Figure 9. A phase harmonic voltage and current maximum, minimum, average, probability value frequency spectrogram.

etc. When refers to STATCOM configuration, a double winding transformer should be equipped as connection transformer, STATCOM is connected to the low voltage side of transformer, the output channel of STATCOM is connected in parallel with the 10 kV or 6 kV bus through the transformer.

Solution 2 is shown in Table 7.

Solution 3: install hybrid APF and capacitor banks.

According to load operation, packet switching capacitor banks, supplying respective phase compensation for load, thus can effectively improve the voltage flicker and other problems. In the 10 kV or 6 kV bus of factory, install a double winding transformer.

In the low voltage side of the transformer, a set of hybrid APF can be installed, thus can effectively filter load harmonic current, when necessary, the load reactive power can also be compensated. Solution 3 is shown in Table 8.

Table 4. Voltage unbalance of measuring point no. 1.

Maximum	Minimum	Average	95% value	International allowable value (95%)	International allowable value (maximum %)	Qualified
0.210	0.013	0.065	0.130	2	4	TRUE

Table 5. Voltage fluctuation of measuring point no. 1.

Voltage fluctuation frequency (/h)	Phase A	Phase B	Phase C	International value	Qualified
r <= 1	2.367	2.041	2.209	4	TRUE
1 < r <= 10	0.596	0.546	0.511	3	TRUE
10 < r <= 100	0.085	0.086	0.084	2	TRUE
100 < r <= 1000	***4.088***	***3.619***	***3.369***	***1.25***	***FALSE***

*Note: bold italics indicate that the type of data does not meet Chinese Industrial Standards (CIS).

Table 6. Voltage flicker of measuring point no. 1.

Long time flicker (2 h)	Maximum	Minimum	Average	International value	Qualified rate (%)	Qualified
Phase A	***1.305***	***0.449***	***0.972***	***1***	***58.125***	***FALSE***
Phase B	***1.645***	***0.443***	***0.881***	***1***	***88.264***	***FALSE***
Phase C	***1.863***	***0.431***	***0.866***	***1***	***91.076***	***FALSE***

*Note: bold italics indicate that the type of data does not meet Chinese Industrial Standards (CIS).

Table 7. Control measures of scheme two.

Device	Capacity	Inlet point	Note	Cost (ten thousand RMB)
STATCOM	5 Mvar	Connected to low voltage side of transformer		20
Hybrid APF	5 MVA	Connected to low voltage side of transformer		20
Connection transformer	10 MVA	10 kV or 6 kV bus of factory	Transformation ratio: 380/11000 or 380/6600	10

Table 8. Control measures of scheme three.

Device	Capacity	Inlet point	Note	Cost (ten thousand RMB)
Hybrid APF	5MVA	Connected to low voltage side of transformer	–	20
Capacitor banks	1200 kvar each phase	35 kV inlet line of load	Compensate each phase	4
Connection transformer	6 MVA	10 kV or 6kV bus of factory	Transformation ratio: 380/11000 or 380/6600	10

4 CONCLUSIONS

A three-phase smart meter based on dual ATmega128L and Zigbee wireless communication protocol was designed and presented in this paper, and its practical engineering application in power quality analysis of industry was described in detail.

1. This smart meter is in coordination with the software which is based on Matlab/Simulink platform, on basis of accurate, rapid detection and analysis of power quality, this system including smart meter and software can put forward reasonable improvements for big dedicated electricity users, and then make compares with these schemes.
2. Testing data of this system is real-time, meanwhile this smart meter utilized MAX125 to ensure the high sampling precision. The analysis function is comprehensive and the simulation ability is strong, thus can laid a good foundation for the scientific management of users' distribution network and make effective and rapid power quality analysis and supply optimized rectification measure for the big dedicated electricity users.
3. Aim at voltage deviation, voltage fluctuation, voltage flicker, harmonic and three-phase unbalance, implement comprehensive managements, not only can reduce the loss of power equipment, but also optimize operating environment, prolong the service life of equipment, and reduce pollution of power grid.
4. Comprehensive treatments and simulation results of power quality problems in certain large manufacturing enterprise of Shaoguan city show progressiveness and high effectiveness of this system.

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Precision measurement of the spatiotemporal evolutions of a long laser pulse during nonlinear propagation

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ABSTRACT: A method for measuring the spatiotemporal evolutions of the long laser pulse during nonlinear propagation is proposed, which not only has advantages of operation simple, convenience and high resolution, but also can measure the fine structure of the long pulse in time domain. The spatiotemporal evolutions of a picosecond laser pulse propagating in different lengths of CS_2 medium are measured by this method. It is found that the pulse width has a trend of slight narrow because the picosecond laser generates slight self-focusing effect in space with increment of the length of CS_2 medium.

Keywords: spatiotemporal evolution; synchronized ultrashort pulse; precision measurement; nonlinear propagation

1 INTRODUCTION

With the rapid development of ultrafast laser technology, the pulse width is from a femtosecond level into an attosecond, for example, 10 as ultrashort pulses have been generated in the ultraviolet and X-wave band. Ultrashort pulse laser technology has a broad application prospects in many fields, such as optical communication, laser-plasma interaction, laser-atom or laser-molecule interaction, and pump-probe spectroscopy[1–7]. The ultrashort pulse is used as a very short time probe, which provides an important tool for investigation of ultrafast chemical reaction in the microscopic world. For an instance, ultrashort pulse is used to detect the ultrafast chemical reaction of atoms-molecules and measure the fine structure of a long pulse in time domain. We know whether the long pulse generates modulation phenomena in time domain by measuring the fine structure of this long pulse. When the long pulse with an initial modulation propagates and amplifies in the large-scale Nd: glass laser system, the modulation will be accumulated and enhanced, which leads the output laser pulse has serious distortion in time domain. So a corresponding measurement method to characterize the fine structure is necessary.

There are two types of methods for measuring the temporal characteristics of laser pulses. One is a pure electronic method, such as photodiodes, high-speed oscilloscope[8] and high-speed streak camera[9]. The other is an all-optical method, such as autocorrelation[10–13], cross-correlation[14–16], Frequency Resolved Optical Gating (FROG)[17–21], Spectral Interferometry (SI)[22], Spectral Phase Interferometry for Direct Electric-field Reconstruction (SPIDER)[23–27], and Pump-Probe technology[6,28,29]. In the above methods, photodiodes and high-speed streak camera are only suitable for measuring the pulse width of hundreds femtosecond due to the effect of measurement resolution, which are not suitable for measuring the pulse width less than 100 fs. FROG and SPIDER have proven capable of measuring the temporal and phase characteristics of a given pulses accurately, but it is need to assume uniform transverse spatial distribution. FROG is needed complex iterative algorithm to retrieve the pulse shape of premeasured pulse in time domain, which only gives approximate information. SPIDER is particularly suited for measuring the spectral phase of a pulse, which has an advantageous for tracking the influence of dispersion on an ultrashort pulse. SPIDER neither moves components nor requires iterative algorithm, but it does not give the pulse width information directly. It needs the multiplied result of its measurement spectrum and phase, and then reconstructs the pulse shape and width by Fourier Transform. Compared with other methods, FROG and SPIDER are more complex in experimental operation. The intensity autocorrelation method is simple operation and no need complex calculation, but it is only suitable for measuring the pulse width information and need to assume the shape of premeasured pulse during the measurement process. While the coherent intensity autocorrelation method can provide some phase information, the accurate phase information is not given directly.

The intensity cross-correlation method is also simple operation and no need complex calculation, whose measurement resolution is associated with the pulse width of a probe pulse. When the probe pulse is very clean in time domain and its pulse width is very short, the measurement resolution is higher. The cross-correlation curve characterizes the temporal fine information of pre-measured pulse directly when the pulse width of a probe pulse is very short.

In this paper, we propose a method for precision measuring the spatiotemporal evolutions of a long laser pulse by synchronized ultrashort pulse according the principle of intensity cross-correlation. And we set up an experimental platform to measure the spatiotemporal evolutions of a picosecond laser pulse after propagating in CS_2 nonlinear media. This paper is organized as following. In Sec. 2 we mainly introduce the experimental setup. In Sec. 3 we analyze the experimental results in detail. Conclusions are presented in Sec. 4.

2 EXPERIMENTAL SETUP

The regenerative amplifier systems of the femtosecond laser and picosecond laser are adjusted to synchronize before doing the experiment. The experimental setup is shown in Figure 1. The femtosecond laser (Coherent Libra) generates a probe pulse, whose main parameters are as following: 800 nm central wavelength, pulse width ~100 fs, 1 KHz repetition. The picosecond laser (High Q) generates a pre-measured pulse, whose main parameters are as following: 1054 nm central wavelength, pulse width ~75 ps, 1 KHz repetition. The femtosecond probe pulse passes through the M1 mirror, delay line, telescopes, M4 mirror, and injects the BBO crystal with a thickness of 0.5 mm. The sum-frequency signal with a wavelength of 455 nm is generated in the BBO crystal by a small angle nonlinear sum-frequency interaction between the femtosecond probe pulse and the pre-measured picosecond pulse. Femtosecond pulse scans the picosecond pulse completely by adjusting the delay line. The cross-correlation curve is obtained by probing the sum-frequency signal light with an oscilloscope and Photoelectric Detector (PD). Therefore the initial fine structure of the picosecond pulse in time domain and its temporal evolutions after CS_2 nonlinear media are obtained. The charge-coupled device CCD (Coherent Laser Cam-HR, pixel: 1280 × 1024, resolution: 6.7 μm × 6.7μm) is used to measure the spatial evolution of the picosecond laser passing through CS_2. So the spatiotemporal evolutions of picosecond laser pulse are obtained by getting the measurement results of the PD and CCD camera. Because the picosecond laser beam spot is smaller than the femtosecond laser, in order to make their beam spots matching, the femtosecond pulse beam spot should be shrunk by using a telescope.

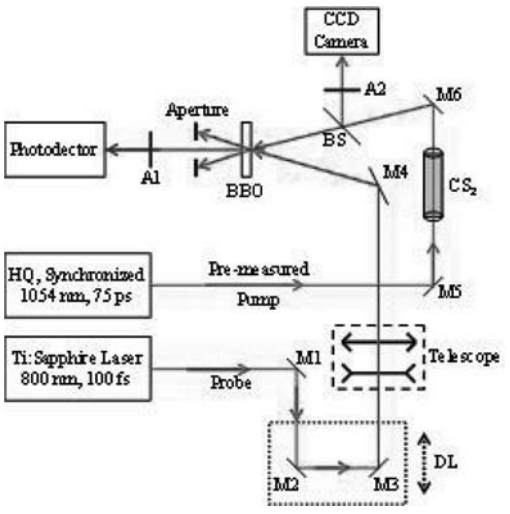

Figure 1. (Color online) Schematic diagram of the experimental setup: M1-M6, silver-coated plane mirror; BS, beam splitter; DL, Delay Line; BBO, β-barium borate crystal; A1 and A2, adjustable neutral density attenuator.

3 EXPERIMENTAL RESULTS AND ANALYSIS

Figure 2 (a–c) shows the spatial intensity evolutions when the picosecond laser propagates in different length of CS_2 nonlinear media. In the experiment, the input energy of picoscond laser is about 2 mJ, whose corresponding peak power is 26.68 kW. The self-focusing critical power of CS_2 media is 1.9 kW, it is easy to see that the input peak power is lager than the self-focusing critical power. So the self-focusing effect is generated when picosecond laser passes through the CS_2 nonlinear media. Although the initial spatial intensity of picosecond laser has lots of random noise modulation, the growth of spatial noise modulation is not obviously. The small-scale self-focusing effect is not obviously.

In order to compare the evolutions of the spatial modulation intensities of the picosecond laser after propagating in a nonlinear media with different length, the spatial intensities profiles at the laser central position are shown in Figure 2 (d). The normalized Gaussian fitting curve is identical in the condition of three different propagation distances from Figure 2 (d),

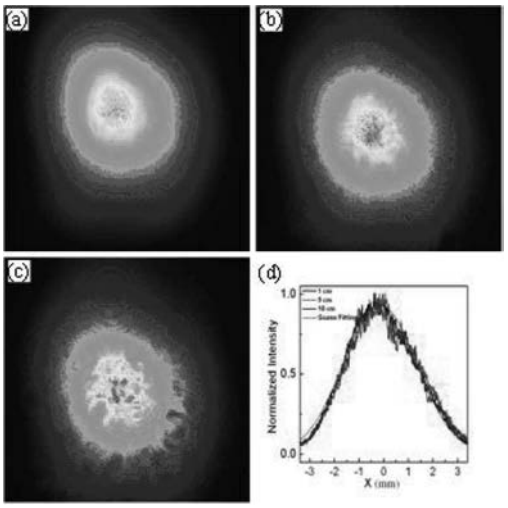

Figure 2. (Color online) (a–c) Variation of spatial intensity distributions of the picosecond laser pulses with the length of CS_2: (a) 1 cm, (b) 5 cm, (c) 10 cm, respectively. (d) Spatial intensity profile distributions of the picosecond laser pulses after propagating in different length of CS_2 nonlinear media. The green curve is Gaussian fitting result.

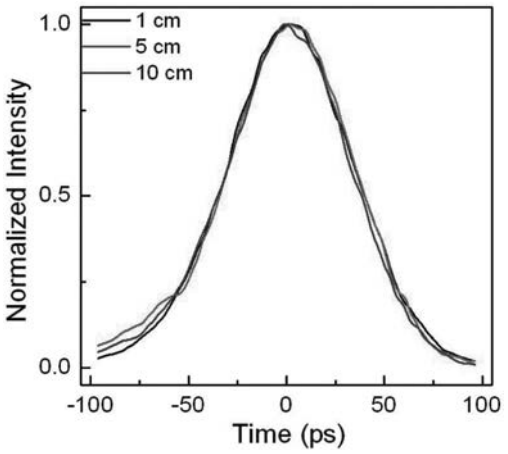

Figure 3. (Color online) measured cross-correlation curves as functions of a length of CS_2 nonlinear media.

which shows that the whole-beam self-focusing effect is not generated.

The temporal evolutions of picosecond laser pulse are measured by the experimental setup [Fig. 1] when the picosecond laser pulse propagates in nonlinear media with different lengths, which are presented in Figure 3. The Full Width At Half Maximum (FWHM) of the cross-correlation curve is about 75 ps when the length of CS_2 is 1 cm, which is the same as the result of no CS_2 [Fig. 3]. The cross-correlation curve also shows that the effect of self-focusing is not obviously. The cross-correlation curves become narrower slightly when the CS_2 length is increased, which shows that the slight self-focusing effect is generated. The self-focusing effect pushes the energy away from the peak position of a beam, thus leading the temporal compression of a laser pulse.

4 CONCLUSIONS

Ultrashort pulse laser technology has a broad application prospects in optical communication, optical switch, optical storage, laser-plasma interaction, laser-atom molecule interaction, and pump-probe spectroscopy. According to intensity cross-correlation principle, we propose a method of measuring the spatiotemporal evolutions of a long laser pulse after nonlinear propagation by a synchronized ultrashort pulse. This method has advantages of simple operation and high resolution, which can measure the temporal shape of a complex picosecond laser pulse. The spatiotemporal evolutions of a picosecond Nd: YLF laser pulse are characterized by a synchronized femtosecond pulse experimentally. We find that the slight self-focusing effect is generated in space of the picosecond laser pulse when the CS_2 length is increased. The temporal shape of the picosecond laser pulse appears narrow phenomenon slightly due to the effect of self-focusing. If there is a proper CCD camera, we believe that this method is also suitable for measuring the spatiotemporal evolutions of a mid-IR laser pulse during nonlinear propagation.

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The research on reliability optimization of software system

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ABSTRACT: To deal with the problem of low efficiency and low convergence speed in searching the global optimum, Niche Genetic Algorithm was used in reliability optimization of software system. Linear programming works with multi-variable and multi-constraint were solved successfully. And also, the searching performance of the genetic algorithms was improved by introducing the stochastic tournament model, the uniform schema crossover operator and the non-uniform mutation in the genetic algorithm. The simulation results show that the Niche Genetic Algorithm can resolve the multi-module complex software system's reliability allocation effectively, which can improve the computing speed and the resolution quality effectively.

Keywords: genetic algorithm; niche genetic algorithm; software reliability

1 INTRODUCTION

The original of the Genetic Algorithm is the computer simulation research on biological systems. It was put forward by professor J.H. Holland in the university of Michigan in 1960s [1]. Genetic Algorithm is a random search technique based on imitating the natural selection, species evolution and population genetics. And it is particularly suitable for getting the optimal solution of combinatorial optimization problems [2]. In recent years, Genetic algorithm has been applied in many fields and has become an important method of researching artificial intelligence and information processing technology [3]. The reliability optimization of software system, which is also called reliability allocation problem of software system, is to find an optimal reliability allocation scheme of software system under the conditions of a certain resource constraints. It makes the system obtain the highest reliability. Generally speaking, there are a large number of local extreme points. It is difficult to solve the global optimal solution accurately. Many scholars have achieved good results in solving the combinatorial optimization problem with intelligent optimization algorithms. But it is still rare to see the research on reliability allocation problem of software system with Niche Genetic Algorithm [4].

The reliability optimization of software system was researched based on Niche Genetic Algorithm in this paper. And it was compared with other heuristic optimization algorithms. The theoretical analysis and simulation results show that Niche Genetic Algorithm is suitable for solving reliability allocation problem of software system. And also the operating efficiency and the solution quality are improved.

2 THE ANALYSIS OF NICHE GENETIC ALGORITHM

In biology, a niche refers to the organizational function or role in a specific environment. Species refer to the common features of organization. The organisms tend to live with each other with similar features and shapes [5]. The individual process of evolution is put in the same population repeatedly in traditional genetic algorithm. With the smoothly genetic exchanging, it is difficult for respective developing of the individual. So the diversity of population is reduced. To solve the problem, the individuals in the initial population are sorted by fitness value firstly. And the similar individuals evolve independently in the niche. The scale of sub-population is changing with the parent population. Let N be the scale of parent population, K be the scale of sub-population, we must have $K = N(D)$, K is a function of D. It can be set firstly according to the characteristics of the problem. D is the variance of the individuals in a population while σ is a constant. When the diversity decreases, D decreases. When D is less than a threshold σ, the sub-population size will reduce to the minimum value 2 in order to stimulate the improvement of the diversity of the population.

3 THE RELIABILITY ALLOCATION MODEL OF SOFTWARE SYSTEM BASED ON THE MODULE SUBSYSTEM

The reliability can be represented as formula 1 for a software system which has n modules and m operations.

$$R(\lambda_1, \lambda_2, \ldots, \lambda_n; \tau) = \exp\left(-\sum_{j=1}^{n} \sum_{i=1}^{m} p_i q_{ij} \lambda_j \tau \right) \quad (1)$$

In the formula, n stands for the number of module. The m stands for the number of operations. τ stands for the running time. λ_j stands for the failure rate of module j. p_i stands for the probability of operation. q_{ij} stands for the running time proportion of module j in operation i.

The running time proportion of module j in the total task can be defined as formula 2.

$$\phi_j = \sum_{i=1}^{m} p_i q_{ij} \quad (2)$$

ϕ_j stands for occupied time of module j in the total task. Then we can get the reliability of module j in the time of ϕ_j. As shown in formula 3.

$$R(\lambda_i; \phi_j \tau) = \exp\left(-\sum_{i=1}^{m} p_i q_{ij} \lambda_j \tau \right) = \exp(-\phi_j \lambda_j \tau) \quad (3)$$

Then, the reliability of module j in the time τ can be represented as formula 4.

$$R(\lambda_i; \tau) = \exp(-\lambda_j \tau) = R(\lambda_j; \phi_j \tau)^{1/\phi_j} \quad (4)$$

Then, the reliability of the software system which has n modules can be represented as formula 5.

$$R(\lambda_1, \lambda_2, \ldots, \lambda_n; \tau) = \prod_{j=1}^{n} \exp(-\phi_j \lambda_j \tau) \quad (5)$$

So the cost of software development can be got as formula 6.

$$TC(\lambda_1, \lambda_2, \ldots, \lambda_n) = \sum_{j=1}^{n} C(\lambda_j) \quad (6)$$

The reliability of the software system can be got to the expression as formula 7.

$$R(\lambda_1, \lambda_2, \ldots, \lambda_n; \tau) \geq \rho \quad (7)$$

In the formula, ρ stands for the reliability target of the software system with n modules and m operations. That is a combinatorial optimization problem with a linear function and multiple constraints. So Niche Genetic Algorithm is imported to solve the engineering problem.

4 RELIABILITY OPTIMIZATION OF SOFTWARE SYSTEM BASED ON NICHE GENETIC ALGORITHM

The genetic algorithm which simulates biological niche genetic is produced by using the concept of niche genetic. The purpose of the algorithm is to form and maintain a variety of sub-populations and do parallel search in the search space. It is often used to solve multimodal function, multi-objective optimization and simulation of complex systems [6]. Niche Genetic Algorithm simulates the fittest principle of biological evolution by maintaining a group of individuals. Repeated selection, crossover and mutation of the individuals are carried out until the global optimal solution is obtained.

4.1 *The coding and the generation of initial population*

The primary task of an algorithm is the encoding method. It affects not only the design method of crossover operator, mutation operator, but also the convergence speed of the algorithm. The genetic algorithm which is based on real-coded is the actual description of the continuous parameter optimization problem. There is no binary encoding and decoding process which can greatly increase the efficiency of the algorithm.

Individual chromosomes are real-coded in genetic algorithm. Each chromosome is represented by feasible solution vector $\lambda = (\lambda_1, \lambda_2, \ldots, \lambda_n)$. At the same time, the upper and lower limits can be determined by the given constrains. That is the search space. The reliability allocation value can be obtained using formula 4 after getting the value of $(\lambda_1, \lambda_2 \ldots, \lambda_n)$. And we can calculate the reliability index of the whole modules by using formula 4 and formula 5 repeated.

Cell generation is used in order to make the initial population distribute throughout the solution space. First, the whole solution space is divided into N small intervals. M individuals in each small interval are generated randomly. Then, an $N \times M$ population is generated. The initial population is evenly distributed throughout the solution space by this method. Each individual has a greater probability to participate in the algorithm because of the significantly difference between each individual. The system's reliability goals can be tested by formula 7. New individuals can be generated until it meets the given constraints. That

is to say, the cost of the software should be within the specific range and the reliability of the system should achieve the given goal.

4.2 *Selection operating*

We use the (μ + λ) selection strategy in the niche technology. It is considered to be the highest kind of selection pressure in evolutionary algorithm between several popular selection mechanisms. The (μ + λ) selection mechanism can produce the fastest local convergence rate when the crossover operator paired in the population. The (μ + λ) selection strategy is to select the μ best individuals in the μ parent individuals and μ an individual cross λ tall individual.

Stochastic Tournament Model is selected in this paper. The winners become the next generation of individuals by the method of competing. In each generation of groups, K individuals are selected to constitute a small group randomly. And then, the fittest individuals are copied to next generation among the K individuals. The copy of the individual still returns to the parent groups and participate in the next random selection. This kind of selection will repeat M times and produce M next generation of individuals. In the method, we usually set $K = 2$.

The basic operation is as follows:

1. K individuals are selected randomly between the individuals of generation T.
2. The fittest individual will enter the generation $T+L$ by comparing the fitness between K individuals. And the copy individual will remains in the generation T.
3. M individuals can be got by repeating the above two steps M times.

4.3 *Crossover operating*

The purpose of crossover operating is to do global searching in genetic algorithms. The emergence of new excellent genetic model can promote the population and improve the accuracy of reconciliation.

Uniform Schema Crossover Operator is used in this paper. A random template is produced before the crossover operating. The crossover operating will carried out if the gene position of individual is 1. Compared to the single point crossover in traditional genetic algorithm, it has greater variation of the area and random mutation probability. And thus the search space is more effective and the local search ability is improved.

The uniform crossover operation is as follows:

1. A long and individual encoded string $w = \omega_1\omega_2 \ldots \omega_i \ldots \omega_L$ is generated randomly. L is the individual coding string length.
2. Two new offspring A' and B' will be produced from A and B generations following the rules.

   If $\omega_i = 0$, then the gene value in position I of A' inherits the value of A while the gene value in position I of B' inherits the value of B.

   If $\omega_i = 1$, then the gene value in position I of A' inherits the value of B' while the gene value in position I of B' inherits the value of A.

4.4 *The mutation operating*

Mutation operation in genetic algorithm means the gene value of certain genes in the individual is replaced by other gene value. The local search ability of genetic algorithm is improved by mutation operation. The diversity is maintained and the premature phenomenon is prevented.

A Nun-Uniform Mutation is used in this paper. It refers to a random perturbation of the original genetic value. The new gene value is the result of the disturbance. A slight change in the solution space is made for each mutation operation.

Set that the mutation operation is from $X = x_1x_2 \ldots x_k \ldots x_L$ to $X' = x_1x_2 \ldots x_k' \ldots x_L$. The range of x_k is $x_k \in [x_{\min}^k, x_{\max}^k]$. Then x_k' is determined by Formula 8.

$$x_k' = \begin{cases} x_k + \Delta(t, x_{max}^k - x_k), & if \quad random(0,1) = 0 \\ x_k - \Delta(t, x_k - x_{min}^k), & if \quad random(0,1) = 1 \end{cases} \tag{8}$$

In the formula, Δ(t,y) is a random function in the range of [0,y]. $y = x_{\max}^k - x_k$ or $y = x_k - x_{\min}^k$.

5 THE ANALYSIS OF SIMULATION RESULTS

The Niche Genetic Algorithm is used to solve the problem of three-module software system reliability. The cost function of its software system takes the number of exponential cost model. We can get the function as follow.

$$\begin{aligned} C(\lambda_1) &= -126\ln(1-\exp(-\lambda_1)) \\ C(\lambda_2) &= -315\ln(1-\exp(-\lambda_2)) \\ C(\lambda_3) &= -238\ln(1-\exp(-\lambda_3)) \end{aligned} \tag{9}$$

The total cost of the development $TC(\lambda_1, \lambda_2, \lambda_3)$ can be got by Formula 6.

The development and investment of the software system is 186,000 yuan and the profit is 48%. Other parameters are as follow: $\phi_1 = 0.21, \phi_2 = 0.48, \phi_3 = 0.31, \rho = 0.975$. The lower limit value of each module is as follow by the analysis of fault trees and the division of the importance of the modules. $(I_1\ I_2\ I_3)$ = (0.921 0.978 0.965).

Table 1. Comparison of niche genetic algorithm and simple genetic algorithm.

Software system	Algorithm	The number of precocity	The number of finding optimal solution	Success rate
Three-module	SGA	156	324	63.5%
	NGA	18	487	87.9%
Five-module	SGA	267	308	52.3%
	NGA	89	415	83.4%

$(w_1\ w_2\ w_3)$ = (0.212 0.487 0.311). The reliability allocation model can be got as follow.

The objective function:

$$Min\left\{f = -126ln(1-exp(-\lambda_1)) \right.$$
$$\left. -315ln(1-exp(-\lambda_2)) - 238ln(1-exp(-\lambda_3))\right\}$$

The constraints are as follow:

$$\begin{cases} e^{-(0.21\lambda_1+0.48\lambda_2+0.31\lambda_3)} \geq 0.975 \\ \lambda_i \geq 0 \qquad (i=1,2,3) \\ e^{-0.21\lambda_1} \geq 0.921 \\ e^{-0.48\lambda_2} \geq 0.978 \\ e^{-0.31\lambda_3} \geq 0.9756 \\ 24+15e^{-0.21\lambda_1} \leq 0.52\times 74.5 \\ 20+71e^{-0.48\lambda_2} \leq 0.52\times 175 \\ 26+32e^{-0.31\lambda_3} \leq 0.52\times 111.5 \\ 70+15e^{-0.21\lambda_1}+71e^{-0.48\lambda_2}+32e^{-0.31\lambda_3} \leq 186 \\ (unit: 1000 yuan) \end{cases} \quad (10)$$

It is a combinational optimization problem with one linear objective function and 3n+2 linear constraints. N means the number of modules. $\lambda_i (i = 1,2,3)$ is the failure rate parameter in the modules. That is to say, the cost of the software should be minimized in a certain task time. And the reliability of the software should be greater than 97.5%.

The Niche Genetic Algorithm is used in the paper to solve the reliability of the three modules. And it is compared with the simple genetic algorithm as shown in Table 1. In the simulation, the scale of the population is 150. The maximum number of the generations is 500. The crossover probability is 0.98 and the mutation rate is 0.01. The approximate optimal solution is: (R1 R2 R3) = (0.96879 0.98176 0.97965), RS = 0.97642. That is the maximum reliability of the software.

From Table 1, we can see that the precocity phenomenon is inhibited effectively. And the global optimal solution is found quickly.

6 CONCLUSIONS

Linear programming works with multi-variable and multi-constraint were solved successfully by using Niche genetic algorithm in multi-module software system. At the same time, the search ability of genetic algorithm was improved by using Stochastic Tournament Model, Uniform Schema Crossover Operator and Non-Uniform Mutation. The simulation results show that Niche Genetic Algorithm in solving the multiple modules of complex software systems reliability allocation problem was efficient and effective. The next step, we will do some research on improving encoding, genetic operators and selection strategies. In short, the reliability of software systems based on genetic algorithm optimization problem worthy of further research.

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Enhancing IP anycast with location redirection for stateful communication

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ABSTRACT: IP anycast has several distinct properties such as server selection, load balancing, server fail-over, and DDoS migration. Unfortunately, its incompatibility with stateful communications limits its adoption to a few stateless services such DNS. This paper explores possible enhancements of the current TCP/IP stack to eliminate this limitation. We propose two alternative approaches to accomplish network location redirection, an essential primitive to compose anycast with stateful communications. We further discuss their implications for various aspects such as routing scalability and security.

Keywords: network architecture; anycast; stateful communication; location redirection

1 INTRODUCTION

IP anycast is one of the several communication paradigms supported by the Internet. In anycast, a group of servers share a same IP address, and independently announce the prefix into the global routing table. Clients trying to contact the anycast address then are routed to the nearest server in terms of routing distance [21]. Figure 1 illustrates an example.

Anycast has several distinct properties such as server selection, load balancing, server fail-over, and DDoS migration [5]; all of these properties are indispensable in building a highly scalable, reliable, and robust distrusted service. Indeed, anycast has been extensively deployed in DNS, one of the most important services of the Internet [1]. Now, anycast has been widely recognized as the key of the scalability and robustness of DNS [7, 9, 18].

Despite of its various advantages, the current form of anycast has a significant limitation: it cannot work with stateful protocols as the Internet routing process it depends on is inherently unstable. This limitation unfortunately causes anycast not applicable for most of Internet applications, which are base on TCP, a connection-oriented thus stateful transport protocol.

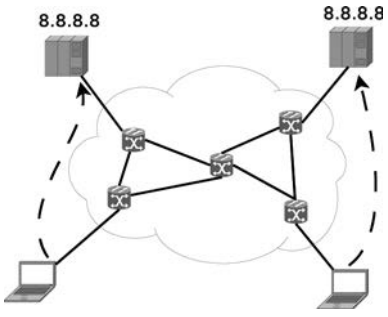

Figure 1. An illustration of IP anycast.

This paper explores possible enhancements of the current TCP/IP stack to compose anycast with stateful communications. Our observation is that the conflict between anycast and stateful communication is caused by lack of a network location redirection primitive in the current TCP/IP stack. Once such a primitive is provided, the limitation of anycast can be eliminated, as a client could initiate a conversation using an unstable anycast address, then be redirected to a stable unicast address for subsequent communications. We propose two location redirection mechanisms: one is in network layer, using a new ICMP message; the other is in transport layer, leveraging a new TCP option. We compare the two mechanisms; further discuss their implications on the inherent properties of anycast such as server fail-over and DDoS migration, as well as other aspects such as routing scalability and security.

2 BACKGROUND

The first formal document of anycast is RFC 1546 [21], in which Partridge et al. described the expected form of IP anycast, as illustrated in Figure 1. They also discussed several possible architectural issues of this communication paradigm, such as addressing, applications on UDP and TCP, comparisons with IP multicast.

In RFC 1546 [21], Partridge et al. considered the advantages and disadvantages of distinguishing anycast address space and operating semantics from unicast. A few subsequent documents stated that there should be some semantic differences between anycast addresses and others. For example, in RFC 2101 [8], Carpenter et al. stated that "there is no way such an address can be anything but a locator; it can never serve as an identifier"; and the IPv6 addressing architecture originally explicitly restricted that an anycast address must not be appeared as a source address, neither be assigned to an IPv6 host [14]. However, these suggested semantic differences are never adopted in implementation and operation. The IPv6 standard was finally refined to remove the restrictions on IPv6 anycast address [15, 23]. Currently, an anycast address is nothing different with an unicast address except that it is assigned to multiple hosts at different locations.

From architectural perspective, although anycast enables several distinct and desirable features such as network layer server selection, load balancing, server fail-over and DDoS protection; it is limited for stateless service as it depends on IP routing to find a service point of a ongoing session, which is inherently unstable; it also has negative effect on routing scalability as the global routing table size grows with the number of anycast groups. From operational perspective, anycast eases the configuration of a global service to be highly available and reliable; on the other hand, it also brings subtleties in other operational respects such as fault diagnosis and fine-grained control [6].

Anycast was not deployed at scale until 2002, where Hardie introduced their experience of adopting anycast for authoritative name servers (they used the term "shared unicast addresses" rather than anycast) [13]. DNS is a stateless service with extremely high traffic volume and reliability requirements, a natural fit of anycast. Since then, anycast has been extensively deployed in DNS, especially top level DNS servers and some popular DNS resolvers [22, 18, 1, 3]. Subsequently, a number of documents on anycast operations and architectural considerations have also been developed [20, 2, 25, 19].

3 IP ANYCAST AND STATEFUL SERVICE: AN ARCHITECTURAL VIEW

Anycast is only applicable for stateless services; this is largely limited its adoption, as most of Internet applications are based on TCP, a connection-oriented transport protocol. A common view of this limitation is that the underlying IP routing is unstable so that packets with anycast destination might go to different servers, resulting broken states of stateful sessions.

We take a different angle to view the limitation of anycast. Our observation is that anycast and stateful communication are not necessarily incompatible. The conflict is caused by the tightly-coupled communication phrases in the current TCP/IP stack. In essence, there are two phases of a communication between a client and a server. The first phase is for the client to locate the server, and then the second phase is for the two to start talking. The problem is that, in some scenarios, the two phrases might not happen at same place. For example, consider the client Alice finds the server Bob at his home, then Bob says let us talk at a cafe. Stateful communication with anycast is essentially such a case: a unstable anycast address should be only used by the client to locate the server, then the second phase should be redirected to a stable unicast address. However, the current TCP/IP stack does not provide network level primitives to express such location redirection behavior to decouple the two phases. Therefore the conflict occurs.

It is worth to clarify the connection between this problem and the well-known locator/identifier split concept [24, 11], which suggests to separate "identifier" used by upper level communications from "locator" used by routing. To some extent, the problem here could be more apparently observed under the locator/identifier split context, as separating identifier from locator naturally draws a line between the aforementioned two communication phases: phase one is between locators; phase two is between identifiers. However, a locator/identifier separation protocol itself is not sufficient to compose anycast with stateful communication; a location redirection primitive is still needed to proactively redirect an unstable anycast locator to a stable unicast one, though the process might be easier to implement with locator/identifier separation architecture than with the current TCP/IP stack.

4 PROPOSED ENHANCEMENTS

In this section, we explore how to add a location redirection primitive in the current TCP/IP stack. In fact, the original document of IP anycast, RFC 1546, has briefly mentioned how anycast could work with TCP [21]. Here we propose two detailed designs, one works in network layer and the other works in transport layer.

4.1 *Network layer redirection*

As location redirection is essentially a network layer primitive, we first consider putting it in

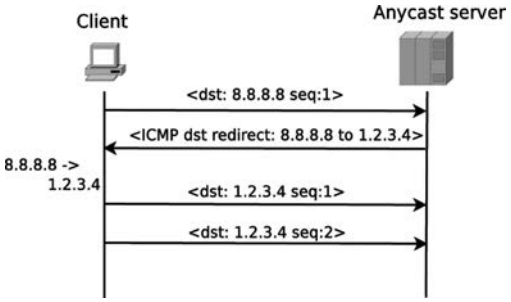

Figure 2. Network layer location redirection via ICMP.

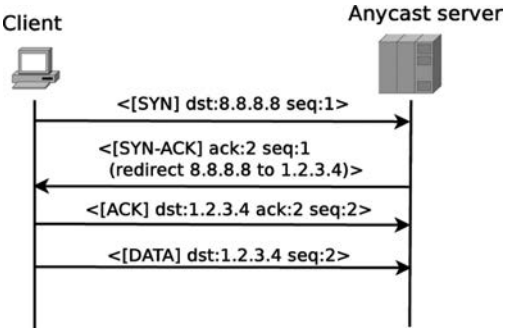

Figure 3. Location redirection via TCP option.

network layer. We proposal a new ICMP message named "ICMP destination redirect" to accomplish this functionality. Figure 2 illustrates how our proposal works:

1. A client sends a packet to an anycast address 8.8.8.8;
2. the anycast interface on the server receives the packet, then responses a ICMP destination redirect telling the client that 8.8.8.8 has been mapped to another (unicast) address 1.2.3.4; the payload of the previous packet is also sent along;
3. upon receiving the ICMP message, the client maintains the mapping as a kernel state; then resend the first packet to 1.2.3.4;
4. as long as the mapping state is valid, the client sends subsequent packets to 1.2.3.4 as well.

The timeout period of the mapping state could be measured empirically, say 5 minutes. In addition, the socket interfaces need to be extended so that a user-space program can explicitly query a mapping, or clear a mapping in case the mapped address fails.

4.2 *Transport layer redirection*

Although implementing location redirection via ICMP is suitable from the viewpoint of layering, the cost is rather high. It potentially causes an extra round-trip to establish a connection, as well as considerable complexity to the current TCP/IP stack. A more pragmatic approach is to implement location redirection on top of TCP. In fact, a slight extension of the TCP three-way handshake is sufficient to accomplish this goal, as shown in Figure 3:

1. a client sends a TCP SYN to an anycast address 8.8.8.8;
2. the anycast interface on the server receives the packet, then responses a normal SYN/ACK, along with a new TCP direct option telling the client that 8.8.8.8 has been mapped to another (unicast) address 1.2.3.4;
3. upon receiving the SYN/ACK, the client sends ACK to 1.2.3.4 to finish the three-way handshake;
4. the client sends subsequent packets of this connection to 1.2.3.4

Compared with the network layer approach, this approach does not require any extra state maintained by kernel. It is also transparent to legacy user-space programs (a few socket interfaces, such as *getpeername*, might need to be modified).

5 DISCUSSIONS ON IMPLICATIONS

The proposed location redirection mechanisms could have some side effects on several aspects. We discuss in detail below.

Server selection, Load Balancing and Fail-over: Apparently, both of the two mechanisms preserve the properties of server selection, load balancing and fail-over. A small side effect of the network layer location redirection is that an anycast instance might fail while its mapping state is valid on a client. The client either suffer a temporary service outage until the mapping state expires; or clear the state once observing a connection timeout, which requires more programming efforts.

DDoS Migration: The original anycast has a nice property of migrating DDoS attacks to some extent. Because an attacker cannot control his attacking traffic to converge on an anycast instance. However, with the enhancement of location redirection, this property does not exist anymore, because the process of location redirection exposes unicast addresses of anycast instances, which then can be specifically targeted.

Routing Scalability: Since the proposed enhancements enable anycast to work with stateful services. Once being adopted, more Internet services

might go to anycast because of its many desirable properties, which is a potential issue if the anycast community becomes crowded. However, we believe this is should not be a practical matter. Since deployment of anycast requires the ability of announcing prefixes globally from multiple sites, which most of service providers do not have.

Security: The proposed mechanisms have subtle side effects on security. Specifically, the proposed mechanisms to some extent increase the ability of on-path or blind attackers. Previously, the attackers can send spoofed packets to disrupt a connection in case they can intercept the connection or make a good guess; with the location mechanisms, the attackers could hijack an address entirely once a spoofed response with redirection is accepted. However, we believe the practical impact is acceptable. Because neither on-path nor blind attackers cannot suppress a legitimate response being received by client, which then could serve as an indicator of anomaly to interrupt the spoofed redirection.

6 RELATED WORK

Architectural Designs: We only recognize a few studies that aimed to enhance IP anycast in current TCP/IP context. Katabi et al. proposed GIA [16] that separates anycast routing from unicast to improve the scalability of anycast. Ballani et al. designed PIAS [4], which adds a new component named anycast proxy; an anycast proxy is that essentially a NAT device which enables reuse of one anycast address for multiple services to improve the scalability as well as other properties of anycast. Besides the above work, a number of researches [27, 12] have been conducted to design application layer anycast services. Although these systems were named as "anycast" and have similar goals, they are fundamentally different with IP anycast. Because working on different layers brings significant differences in their technical properties and challenges.

Measurement Studies: Anycast has attracted lots of measurement efforts. A number of studies [7, 9, 18] investigated the behaviors of anycast of DNS root servers by examining server-side query log. Some studies on the other hand, evaluated anycast by active probing. Sarat et al. [22] evaluated the effectiveness of anycast in DNS by active probing from PlanetLab nodes; Liang et al. [17] measured query latencies of DNS root servers and a few TLDs from a large number of open resolvers; Ballani et al. [6] designed dedicated experiments by leveraging a large number of client to actively probe several anycast groups to study several properties of anycast such as proximity, fail-over time, affinity and client load distribution. Overall, these measurement studies confirmed the effectiveness of anycast in increasing performance and reliability. However, these studies, especially the one conducted by Ballani et al. also revealed subtle behaviors of anycast caused by complicated interactions of network topologies and routing policies.

Ye et al. [26] and Xun [10] developed techniques utilizing specific DNS queries and heuristic inference to reverse engineering anycast the number and placements of anycast instances in DNS.

7 CONCLUSION

We have presented two alternative enhancements of the current TCP/IP stack to accomplish network location redirection, which is essential to compose anycast with stateful communications. We have also discussed their implications for various aspects.

Although the proposed enhancements require changing the semantics of the current TCP/IP stack, a great obstacle of their deployability. We believe some vendors such as CDN providers would like to have such features because of the attractive benefits of anycast to their services. Future work includes complete implementation of the proposals and detailed evaluation of their overhead and compatibility with legacy applications.

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Computer, Intelligent Computing and Education Technology – Liu, Sung & Yao (Eds)

On adaptability of web-based learning for science and engineering students

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ABSTRACT: In the higher education information environment, various factors have different influence on web-based learning. In order to improve the learners' web-based learning performance, we provide web-based learning adaptability questionnaires in accordance with the science and engineering students' characteristics and their learning status while studying the basic course University Physics online. Using factor analysis method to extract 11 common factors, which is the potential impact of web-based learning adaptability determinants, we gain the statistical model of web-based learning adaptability. According to the 11 common factors, strategies of intervention are then proposed to improve the low performance problems of web-based learning.

Keywords: science and engineering; web-based learning adaptability; SPSS; factor analysis; University Physics

1 INTRODUCTION

Web-based learning field is an open and self-organizing system. Not only the individual learners have many differences, but also multi-dimensional objective and subjective factors have an effect on it. Science and engineering students' habits are formed during the basic courses learning, so we can do empirical research on the basic courses to obtain statistical regularity. As a science and basic science course and a scientific quality education course, University Physics is the basis of other scientific and technical courses and one of the important courses for logical, exploratory and innovative high-quality personnel training. Therefore, web-based learning adaptability questionnaires are provided. The students of science and engineering in HNU are the objects of this survey and University Physics being the course in this study. Using the physics paradigm, we abandon secondary factors, highlight main factors and make the cluster analysis as well as dimensionality reduction on the multidimensional variables, thereby gaining the statistical model of web-based learning adaptability, go into the "quantity" research level of soft science emphasized. On this basis, we study web-based learning intervention strategies.

2 RESEARCH METHODS

This study uses methods of questionnaires and factor analysis by SPSS19.0. Based on the summary of impact factors of web-based learning adaptability at home and abroad, we determine the formal questionnaire dimensions. There are 8 first-order factors which named A, B … H respectively, including learning attitude, motivation, methods, environment, information literacy, physical and psychological health, interpersonal communication and teachers' assistance. The 8 first-order factors consist of 20 second-order factors. Learning attitude includes learning concept and learning situation. Motivation includes internal motivation and external motivation. Methods include learning skills and habits. Environment includes network environment, school environment and social environment. Information literacy includes information knowledge, skills and consciousness. Physical and psychological health includes autonomy, attention, adaptability and physical function. Interpersonal communication includes teacher-student relationship and students' relationship. Teachers' assistance includes shared resources provision and organization and guide of activities. According to the first-order factors' capitals, the second-order factors use digital subscript in turn to represent, such as

A_1 represents learning concept and A_2 represents learning situation. In the end, the Richter 5-point method is adopted to establish 41 subjects.

Before questionnaire testing, we have carried on the mobilization work. The questionnaire has been uploaded to the HNU curriculum center website in the form of electronic version, so that students can download and fill forms freely. And we have told them the E-mail to send back completed questionnaires. Finally, 330 questionnaires have been recovered, including 115 girls and 205 boys, excluding 10 blank or invalid questionnaires. The effective rate is 97%. 33 majors cover all science and engineering colleges of HNU, belonging to four grades, giving priority to freshman.

3 FACTOR ANALYSIS

3.1 *Reliability, KMO and Bartlett test of sphericity*

According to the analysis of reliability, the cronbach's alpha is 0.914. It is greater than 0.6 and close to 1. It shows that the questionnaire has good reliability.

The sample's KMO value is 0.880. On the basis of KMO measures given by Kaiser, they are suitable for factor analysis. The concomitant probability value got from Bartlett test of sphericity is 0.000 which is less than 0.05. The questionnaire is considered suitable for factor analysis as well. (Yang. 2004).

3.2 *Extract common factors*

Seen from Table 1, the cumulated variance contribution ratio of the 11 common factors is 83.363%. Variance contribution rate is an indicator to measure common factors of the relative importance. The common factors can contribute more with greater value. 11 common factors reflect 83.363% of the original information and they have reached the standard of most information interpretation.

3.3 *Common factors constitution*

Many variables in component matrix are high or similar. Nevertheless, the rotated component matrix can make structure simplified and meaning clear. Seen from Table 2, factor 1 contains B_1, B_2. Factor 2 contains A_2, F_2 and F_4. Factor 3 contains H_1, H_2. Factor 4 contains G_2. Factor 5 contains E_3. Factor 6 contains E_1. Factor 7 contains A_1. Factor 8 contains F_1. Factor 9 contains D_2. Factor 10 contains G_1. Factor 11 contains D_3. According to the contribution ratio of the factors displayed in Table 1, we can see that whichever factor comes before the other in the sequence certainly contributes more. In view of the larger contribution factors, we can intervene the

Table 1. Total variance explained.

	Initial eigenvalues			Rotation sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	6.670	33.349	33.349	2.574	12.870	12.870
2	1.893	9.465	42.814	2.386	11.930	24.800
3	1.566	7.832	50.646	1.896	9.481	34.281
4	1.149	5.744	56.391	1.618	8.089	42.370
5	1.016	5.078	61.469	1.284	6.418	48.788
6	0.913	4.565	66.035	1.244	6.219	55.008
7	0.840	4.202	70.236	1.221	6.103	61.110
8	0.723	3.616	73.852	1.193	5.966	67.076
9	0.653	3.266	77.118	1.094	5.472	72.548
10	0.640	3.200	80.318	1.082	5.410	77.958
11	0.609	3.045	83.363	1.081	5.404	83.363
12	0.549	2.747	86.109			
13	0.485	2.426	88.536			
14	0.432	2.159	90.695			
15	0.409	2.043	92.738			
16	0.367	1.834	94.572			
17	0.341	1.703	96.275			
18	0.279	1.396	97.671			
19	0.248	1.239	98.910			
20	0.218	1.090	100.000			

Table 2. Rotated component matrix.

	Component										
	1	2	3	4	5	6	7	8	9	10	11
A_1	0.347	0.158	0.257	0.019	0.166	0.119	0.746	0.048	–0.052	0.040	0.207
A_2	0.316	0.724	0.271	0.056	0.014	0.046	–0.012	0.093	–0.099	–0.071	0.003
B_1	0.729	0.212	0.256	0.156	0.031	0.097	0.065	0.238	0.009	–0.003	0.015
B_2	0.732	0.201	0.163	0.176	0.137	0.058	0.298	0.051	0.093	0.021	0.082
C_1	0.125	0.020	0.166	0.532	–0.154	–0.030	0.485	0.364	0.288	0.062	–0.041
C_2	0.528	0.202	0.228	0.578	0.149	0.094	0.098	0.229	0.048	0.138	0.110
D_1	0.614	0.204	0.095	–0.006	0.129	0.146	0.118	–0.032	0.276	0.325	0.295
D_2	0.145	0.061	0.268	0.117	0.021	0.022	0.024	0.031	0.879	0.027	0.166
D_3	0.125	–0.003	0.081	0.173	0.041	0.026	0.100	0.100	0.148	0.065	0.913
E_1	0.098	0.141	0.101	0.074	0.031	0.921	0.120	0.078	0.018	0.119	0.052
E_2	0.327	0.034	0.065	0.094	0.526	0.508	–0.137	0.269	0.036	0.101	–0.070
E_3	0.095	0.121	0.135	–0.001	0.908	0.023	0.125	0.025	0.013	0.144	0.067
F_1	0.163	0.113	0.069	–0.035	0.086	0.126	0.071	0.904	0.018	0.026	0.101
F_2	–0.027	0.890	–0.083	–0.035	0.066	0.055	0.040	0.041	0.015	0.044	0.069
F_3	0.452	0.480	0.054	0.206	0.065	0.117	0.429	0.053	0.186	0.100	–0.050
F_4	0.339	0.766	0.002	0.114	0.088	0.088	0.149	0.038	0.159	0.103	–0.063
G_1	0.105	0.053	0.209	0.009	0.167	0.138	0.044	0.037	0.024	0.917	0.063
G_2	0.132	0.035	0.058	0.900	0.019	0.081	0.008	–0.128	0.054	–0.040	0.155
H_1	0.102	0.039	0.837	0.096	0.116	0.074	0.187	0.045	0.207	0.122	0.017
H_2	0.258	0.037	0.838	0.082	0.064	0.064	0.050	0.061	0.094	0.123	0.088

Table 3. Component score coefficient matrix.

	Component										
	1	2	3	4	5	6	7	8	9	10	11
A_1	–0.033	–0.073	0.033	–0.176	0.071	0.066	0.801	–0.120	–0.220	–0.129	0.133
A_2	0.020	0.379	0.249	–0.010	–0.091	–0.051	–0.238	0.013	–0.231	–0.150	0.058
B_1	0.518	–0.084	0.047	–0.071	–0.140	–0.058	–0.224	0.083	–0.128	–0.096	–0.067
B_2	0.476	–0.124	–0.092	–0.084	0.006	–0.073	0.100	–0.127	–0.022	–0.105	–0.045
C_1	–0.235	–0.059	–0.070	0.321	–0.123	–0.103	0.450	0.321	0.190	0.114	–0.235
C_2	0.159	–0.016	–0.002	0.361	0.029	–0.109	–0.184	0.108	–0.153	0.090	–0.017
D_1	0.419	–0.072	–0.176	–0.217	–0.085	0.005	–0.100	–0.177	0.188	0.220	0.171
D_2	–0.048	–0.004	–0.020	–0.100	0.048	0.021	–0.131	–0.025	0.966	–0.132	–0.041
D_3	–0.096	0.023	–0.023	–0.001	–0.029	–0.009	–0.053	0.046	–0.089	–0.063	0.953
E_1	–0.166	–0.003	0.013	–0.031	–0.192	0.945	0.119	–0.118	–0.009	–0.086	0.038
E_2	0.121	–0.115	–0.084	0.038	0.372	0.329	–0.268	0.128	0.078	–0.113	–0.150
E_3	–0.195	0.013	–0.018	0.044	0.897	–0.193	0.128	–0.041	0.029	–0.097	–0.008
F_1	–0.092	0.008	–0.041	–0.097	–0.016	–0.072	–0.056	0.885	–0.025	–0.001	0.074
F_2	–0.328	0.552	–0.019	0.006	0.025	–0.014	–0.036	0.033	0.001	0.027	0.138
F_3	0.085	0.100	–0.159	0.009	–0.025	0.013	0.337	–0.085	0.137	0.038	–0.190
F_4	–0.003	0.341	–0.104	0.015	–0.003	–0.035	–0.006	–0.048	0.142	0.063	–0.127
G_1	–0.082	–0.002	–0.027	0.047	–0.120	–0.104	–0.047	0.031	–0.120	1.034	–0.061
G_2	–0.130	0.023	–0.019	0.731	0.070	0.043	–0.156	–0.188	–0.123	–0.042	0.073
H_1	–0.220	0.024	0.578	–0.021	0.025	0.012	0.058	–0.046	0.028	–0.061	–0.075
H_2	–0.006	0.002	0.599	–0.050	–0.082	–0.022	–0.171	–0.040	–0.138	–0.045	0.035

influence factors of high factor weight to improve web-based learning adaptability.

3.4 *Component score coefficient matrix*

Table 3 called component score coefficient matrix expresses the linear relationship between common factors and original variables. We can calculate 11 factors' score of 320 samples by taking advantage of component score coefficient matrix. The formulas are as follows:

$$\begin{aligned} F_1 &= -0.033 \times x_1 + 0.020 \times x_2 \ldots - 0.006 \times x_{20} \\ F_2 &= -0.073 \times x_1 + 0.379 \times x_2 \ldots + 0.002 \times x_{20} \\ &\ldots \\ F_{11} &= 0.133 \times x_1 + 0.058 \times x_2 \ldots + 0.035 \times x_{20} \end{aligned} \quad (1)$$

where F = factor score; x = original variable.

At the same time, in accordance with 11 common factors' scores, we can use eigenvalue as the weight and calculate the composite score E. That is to say, we get the mathematical expression of factor analysis statistical model. Thereby, web-based learning adaptability is quantified.

$$E = 2.574 \times F_1 + 2.386 \times F_2 \ldots + 1.081 \times F_{11} \quad (2)$$

Using the formulas, we can evaluate web-based learning adaptability ability of learners. Afterwards, we finished the dimension reduction of 20 original variables. The new common factors have been given the new meanings.

3.5 *Verification*

In order to verify the effectiveness of this study, we conduct the single-sample K-S test for composite scores and compare with normal distribution. The results show that the average of composite score is 0.000, the standard deviation is 5.30826, the Z statistic of K-S is 0.627, and the corresponding concomitant probability value is 0.826 which is greater than significance level 0.05. Thus, it shows that the 320 students' composite scores of web-based learning adaptability are in line with normal distribution. Meanwhile, according to the statistics of 2530 science and engineering students' University Physics final grade in HNU, it can be seen that the grade correspond to normal distribution as well from Figure 1. Consequently, the study is consistent with the overall learning situation in HNU.

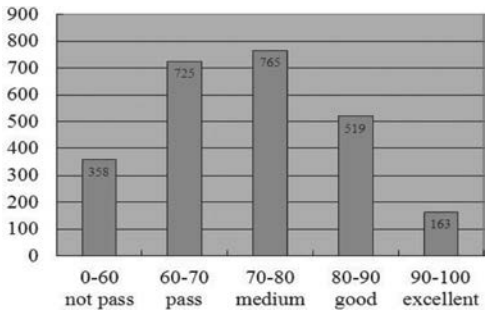

Figure 1. University Physics final grade histogram.

4 DISCUSSION

The above is the factor analysis of web-based learning adaptability research for science and engineering students in HNU. In accordance with classification and summary of contribution ratio and original dimensions for 11 common factors, they can be named in turn as follows. Learning motivation comprehends common factor 1. Learning personality covers common factor 2, 7 and 8. Teachers' assistance contains common factor 3. Interpersonal communication includes common factor 4 and 10. Information literacy includes common factor 5 and 6. Learning environment is constitutive of common factor 9 and 11. In view of the importance of common factors for web-based learning adaptability, we put forward the following several aspects of the intervention strategies for reference.

4.1 *Learning motivation*

The constitution of web-based learning tasks should be slightly improved within the scope of the learners' ability, so that learners can get emotional experience of success and challenges. Next, we can adopt reasonable competition methods to stimulate external motivation. However, teachers need to make the right guidance of appraisal methods, avoid negative impact brought by the competition, pay attention to students' task completion at any time and give timely encouragement.

4.2 *Learning personality*

The survey shows that even the subjects which students are interested in, the time of efficient concentration is only 15 to 20 minutes. So the web-based learning content should be rational planned to make sure that learners can finish them in short time. On the teachers' side, they should supervise and guide students to reasonable planning time.

4.3 *Teachers' assistance*

Teachers should provide reasonable web-based learning resources, create problem situation to lead to knowledge and set up good navigation mechanism

for learners. In addition, teachers should organize web-based learning activities to accomplish specific tasks for the target and promote healthy competition and teamwork. In the meantime, guiding students to correct attribution is necessary.

4.4 *Interpersonal communication*

Virtual learning community can be organized and built by teachers to strengthen the collective sense of belonging in the web-based learning process. It is also necessary to establish rules and guide rational group division.(Wu. 2012) In order to promote the emotional interaction between teachers and students, teachers should actively participate in students' online discussion activities and fully play the role of good guiders and organizers.

4.5 *Information literacy*

Before the network teaching, we can consider to set up dedicated information technology courses to standard students' information consciousness, guide the correct learning concept and introduce information knowledge of search engine and pictures download. We should provide teachers' training of instructional design and network teaching theory and application in order to assist students' efficient web-based learning. (Qiu. 2009).

4.6 *Learning environment*

On the basis of ensure software and hardware facilities, schools can establish personal file for each student to track students' progress and help teachers to develop targeted solutions. And society should standardize the public opinion direction. Relevant government departments should take measures to guide the healthy development of web-based learning and promote the establishment of a learning society.

5 CONCLUSIONS

At present, the research of web-based learning adaptability at home and abroad has a great space for development. It is limited to treat science and engineering students in HNU as the objects of this study. We hope to throw out a minnow to catch a whale and provide reference for a wide range of higher education informatization practice.

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A novel method for optimal capacitor placement in radial distribution system

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ABSTRACT: In this paper, a new approach based on improved Particle Swarm Optimization (PSO) algorithm is proposed in radial distribution system. The improved PSO can find optimal location and sizes of capacitors in the system by dividing reasonable search field. Finally the proposed method is implemented on the IEEE33 standard bus system.The obtained results are then compared with accurate moment method to validate its effectiveness.

Keywords: PSO; radial distribution system; optimal power flow; capacitor placement

1 NOMENCLATURE

Ke	Line loss cost factor
P_{Li}	Line loss
N	Number of bus bar
Km	Capacitor installation cost
M	Amount of installation place
Kc	Capacitor cost
Qci	Size of capacitor
Kv	Voltage penalty factor
dU	Deviation of voltage
$Rand( )$	Random function
V	Particle velocity
x	Particle location
ϖ	Inertia weight

2 INTRODUCTION

Optimal distribution system planning plays a very important role in the growth of the distribution system network and in the effective use of the distribution system. With the continuing increase in load demand, the future expansion of the network depends on the study of the load flow of the distribution system network and this is one of the most important research fields in electrical engineering. With the growing effort to reduce system losses and to increase the efficiency of the system and proper voltage profile, research on optimal distribution system planning has been conducted[1].

The shunt capacitors installation on radial distribution is commonly used to improve power flow control, system stability enhancement and power factor correction, managing voltage profile, and reducing active power and energy loss in distribution network. The method using Genetic Algorithm (GA) in [2] can compute the (near) global solution with a lower probability of getting stuck at a local optimum and weak dependency on initial conditions, while avoiding numerical problems in large system. A combined Power Loss Sensitivity (PLS) index-based approach is proposed in [3] to determine the optimal location of the capacitors in the Radial Distribution System (RDS) based on the real and reactive combined loss sensitivity index. Besides, [4] uses a sensitivity analysis based method to select the candidate locations for the capacitors. A new optimization method using a Genetic Algorithm is proposed to determine the optimal selection of capacitors.

The other methods based on intelligent algorithm are researched, such as an Improved Harmony Search (IHS) algorithm is applied to solve the optimal capacitor placement problem[5]; a general solution algorithm based on simulated annealing for optimal capacitor placements in distribution systems is proposed and analyzed in[6];[7] shows a fuzzy decision making which using a new evolutionary method known as Bacteria Foraging Algorithm (BFA). Besides, the methods perform efficiently that a loop-analysis based analytic algorithm is developed in[8] to efficiently calculate the optimal settings of capacitor with time-varying load and that an approach based on dynamic programming is presented to reach such an optimal schedule such that the total feeder loss in a day is minimized[9–10].

The advantages with the addition of shunt capacitors banks are to improve the power factor, feeder

voltage profile, power loss reduction and increases available capacity of feeders. Therefore it is important to find optimal location and sizes of capacitors in the system to achieve the objectives[11–12].

In this paper, The improved PSO algorithm is discussed firstly and divided search field is introduced. Finally this method is implemented on the IEEE33 standard bus system for optimal capacitor placement. The results compared with the accurate moment method validate that the proposed method needs to take a little more time but it is more effective to search optimal solutions than accurate moment method.

3 PROBLEM FORMULATION

For finding the best shunt capacitor size and location in the radial distribution system to minimize the costs incurred due to power loss and capacitor installation, considering the voltage profile, the following objective function is designed:

$$min\,\mathrm{F} = k_e \sum_{i=1}^{n} P_{Li} + k_M M + k_c \sum_{i=1}^{M} Q_{ci} + k_v \sum_{i=1}^{n} (\mathrm{d}U_i)^2 \tag{1}$$

Subject to:

$$\begin{cases} P_i = U_i \sum_{j=1}^{N} U_j (G_{ij} \cos\theta + B_{ij} \sin\theta) \\ Q_i = U_i \sum_{j=1}^{N} U_j (G_{ij} \sin\theta - B_{ij} \cos\theta) \end{cases} \tag{2}$$

$$\begin{cases} V_{min} < V < V_{max} \\ Q_{ci} > 0 \end{cases} \tag{3}$$

The deviation of voltage is defined by:

$$\mathrm{d}U = \begin{cases} V_{min} - V & (V < V_{min}) \\ 0 & (V_{min} < V < V_{max}) \\ V - V_{max} & (V > V_{max}) \end{cases} \tag{4}$$

To find the optimal capacitor location and sizing in radial distribution network, backward/forward sweep power flow is used to compute power loss and voltage.

4 IMPROVED PSO ALGORITHM

Figure 1 shows the principle of PSO algorithm. A group of random particles (solutions) are initialized. In every iteration, each particle is updated

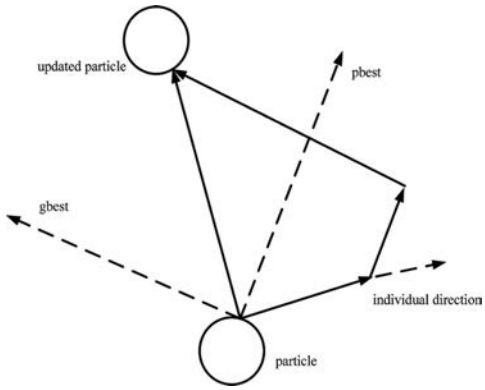

Figure 1. The principle of PSO algorithm.

by following two "best" values. The one, called pbest, is the best solution (fitness) which has been searched so far and also stored by a particle. The other one, called gbest (global best), is the best solution (fitness) which has been searched so far and also stored by particle swarm. The PSO algorithm is expressed as follows (5–6):

$$v_{t+1,i} = \omega v_{t,i} + c_1 rand()\,(pbest_{t,i} - x_{t,i}) + c_2 rand()\,(gbest_t - x_{t,i}) \tag{5}$$

$$x_{t+1,i} = x_{t,i} + v_{t+1,i}\ (1 \le i \le m, \quad 1 \le d \le D) \tag{6}$$

In radial distribution network, lower voltage always occurs at the end of branches of system. Such that the further distance from the root node, the larger amount of reactive power is needed. But nodes which feed large load also need more reactive power. So accurate moment is defined as follows:

$$\mathrm{T}_q^2(i) = R_{di}\left(\frac{Q_{bi}^2}{U_i^2} - \sum_{j \in i} \frac{Q_{bj}^2}{U_j^2}\right) \tag{7}$$

According to accurate moment, bus bar numbers can be reorder by descending order. So optimal capacitor location(s) can be found.

The classical PSO algorithm can not slove problem of reactive power optimization in distribution network with discrete variables, called mixed-integer nonlinear programming problem. So PSO algorithm needs to be improved. Figure 2 shows that search field, a set of discrete variables (capacitor location), is divided into n sections by accurate moment.

So a new location vector is defined by:

$$y = (y_1, y_2, \ldots, y_n)^T \tag{8}$$

where yi = any value from number i section.

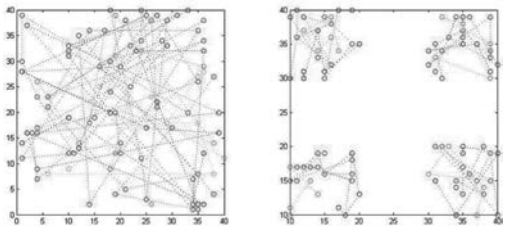

Figure 2. The search field is divided into 4 sections ($n = 4$).

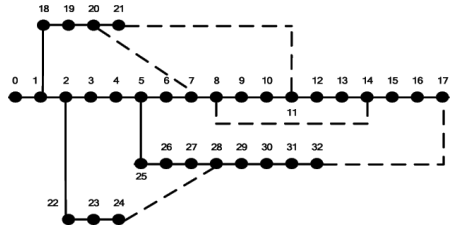

Figure 4. IEEE33 standard bus system.

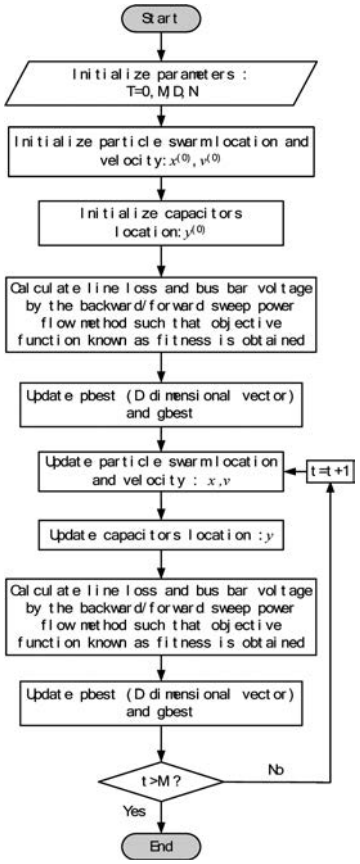

Figure 3. Optimal capacitor placement flowchart.

Now an augmented vector is described as follows:

$$\overline{x} = \begin{pmatrix} x \\ \cdots \\ y \end{pmatrix} \tag{9}$$

where x = sizing of capacitor.

Table 1. Loads and lines data of the IEEE33 standard system.

		Impedance (Z_{ij})	Load (Q_j)
i	j	p.u.	KVA
0	1	0.0922 + j0.047	100 + j60
1	2	0.4930 + j0.2511	90 + j40
2	3	0.3660 + j0.1864	120 + j80
3	4	0.3811 + j0.1941	60 + j30
4	5	0.8190 + j0.7070	60 + j20
5	6	0.1872 + j0.6188	200 + j100
6	7	0.7114 + j0.2351	200 + j100
7	8	1.0300 + j0.7400	60 + j20
8	9	1.0440 + j0.7400	60 + j20
9	10	0.1966 + j0.0650	45 + j30
10	11	0.3744 + j0.1238	60 + j35
11	12	1.4680 + j1.1550	60 + j35
12	13	0.5416 + j0.7129	120 + j80
13	14	0.5910 + j0.5260	60 + j10
14	15	0.7463 + j0.5450	60 + j20
15	16	1.2890 + j1.7210	60 + j20
16	17	0.3720 + j0.5740	90 + j40
17	18	0.1640 + j0.1565	90 + j40
18	19	1.5042 + j1.3554	90 + j40
19	20	0.4095 + j0.4784	90 + j40
20	21	0.7089 + j0.9373	90 + j40
2	22	0.4512 + j0.3083	90 + j50
22	23	0.8980 + j0.7091	420 + j200
23	24	0.8960 + j0.7011	420 + j200
5	25	0.2030 + j0.1034	60 + j25
25	26	0.2842 + j0.1447	60 + j25
26	27	1.0590 + j0.9337	60 + j20
27	28	0.8042 + j0.7006	120 + j70
28	29	0.5075 + j0.2585	200 + j600
29	30	0.9744 + j0.9630	150 + j70
30	31	0.3105 + j0.3619	210 + j100
31	32	0.3410 + j0.5362	60 + j40
7	20	2 + j2	Tie switches
8	14	2 + j2	
11	21	2 + j2	
17	32	0.5 + j0.5	
24	28	0.5 + j0.5	

5 APPLICATION IN SOLVING THE OPTIMAL CAPACITOR PLACEMENT

Figure 3 shows a flowchart which describes optimal capacitor placement procedure involved in improved PSO algorithm.

6 TEST RESULTS

For optimizing capacitor placement and validating its effectiveness the improved PSO algorithm is applied on the IEEE33 standard bus distribution system shown in Figure 4.

Loads and lines data of the IEEE33 standard bus system are shown in Table 1. Table 2 and Table 3 show the results of the test. The results including optimal solutions, fitness and time are obtained in 2 cases ($n = 2$ and $n = 3$) and in Tables 2 and 3 results compare improved PSO with accurate moment.

Figures 5 and 6 describe a histogram that visually demonstrates the fitness (or time) of improved PSO compared with accurate moment method in 2 cases respectively.

Table 2. Optimal capacitor placement (n = 2).

Method	Location	Size (kVar)	Fitness (¥)	Time (s)
Improved PSO	14	359	919606	81.864
	29	1032		
Accurate moment method	30	737	947819	75.654
	6	820		

Table 3. Optimal capacitor placement (n = 3).

Method	Location	Size (kVar)	Fitness (¥)	Time (s)
Improved PSO	11	298	916306	82.432
	29	1266		
	1	1337		
Accurate moment method	30	605	1041105	76.959
	6	988		
	3	534		

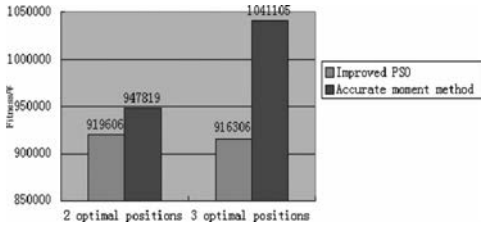

Figure 5. Fitness of 2 methods in 2 cases.

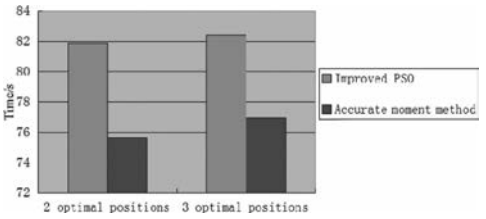

Figure 6. Time of 2 methods in 2 cases.

7 CONCLUSION

The application of improved PSO algorithm in determining the optimal location(s) and sizing of shunt capacitors in IEEE33 standard bus system has been presented. Improved PSO algorithm can find optimal location(s) of shunt capacitors by dividing some special sections according to accurate moment method.

The obtained results validate that the proposed method is more effective in searching optimal solution(s) than accurate moment. The improved PSO gives less total costs than accurate moment method. Moreover in cases (n = 3 or more) the proposed method is better than accurate moment method in optimal location(s) of shunt capacitors. So the proposed method can optimize capacitor placement in radial distribution network system effectively and is better in optimal location(s) of shunt capacitors than accurate moment method except for taking a little more time.

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Computer, Intelligent Computing and Education Technology – Liu, Sung & Yao (Eds)

Design and construction of the government external access network based on EPON

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ABSTRACT: The Shanghai government external network is a metropolitan area network that serves the bureaus. The access nodes of the bureau are widely distributed in the city. The ethernet access network link has been built, but it has many problems such as the powerless access network switch, loops in the network, broadcast storm. With the development of the network, the demands of network bandwidth and QOS are increasing. EPON is a technology with the advantages of the low-price equipments and passive optical network, high bandwidth. It becomes the best choice of the access network. In this paper, it introduces the principle of EPON and the scheme of the Shanghai government external access network (EPON). According to implementation of the scheme, it will provide a high bandwidth, scalable, stable, uniform access network. This scheme also meets the construction principle and target of the national government external network.

Keywords: Ethernet Passive Optical Network (EPON); government external access network

1 INTRODUCTION

1.1 *Background*

1.1.1 *Market background*

The access network is the basement of the next generation national informatization infrastructure. It is also the basement of the intelligent channel control. The next access network must use the IP protocol as the network carrying protocol. Constructing the intelligent channel with high bandwidth and efficiency is a target. Through speed up the development of the network technology, space extension, optimize network architecture and increase intelligent level, the company can achieve some targets such as high access network, full IP carrying network, controlled network resource, convergence network service. If the company builds a good access network, the company will have an uniform and convergent carrying platform for the service and application.

1.1.2 *Trade and technical background*

Shanghai government external network has almost 1200 customers. As the network contractor, Oriental Cable Network Co. Ltd actively participates in the progress of the social informatization. The company assists the sustainable development of the Shanghai economy in the aspects of the network infrastructure and digital television. The company is an innovative and energetic internet service provider. It has built a sustainable development model that meets the requirements of the information and communication services with the economic development.

Shanghai government external network is built by Oriental Cable Network Co. Ltd. As a Shanghai local high IP network, it has finished the construction of the backbone network and access network by the several previous projects. It has provided the MPLS VPN capability of the whole network. The whole Shanghai government external network services are in operation by this network.

Oriental Cable Network Co. Ltd recognizes the optimized network service quality and a variety of application services as the key point of the value for the customers.

1.2 *Target*

The target is building a 1000Mbps Ethernet Passive Optical Network link for Shanghai government external network. The EPON link will be satisfied with the Shanghai government external network services three years. The specific content is as follows.

In the city, every core room will increase an OLT, every access room will increase an OBD, every customer room will increase an ONU.

In the suburban district, every core room will increase an OLT, every access room will increase an OBD, every customer room will increase an ONU, some remote access rooms will increase an

OLT and an OBD, some core rooms will increase a convergence switch that connects the PE in the core room.

2 EPON TECHNOLOGY

2.1 *Principle*

EPON stands for Ethernet Passive Optical Network. The topology of EPON is a point-to-multipoint network topology. The target of EPON provides a data, voice and video service access network.

The network structure of EPON is shown in Figure 1. It consists of the OLT, ONU, OBD. OLT stands for Optical Line Terminal. ONU stands for Optical Network Unit. OBD stands for Optical Branching Device. OLT (Optical Line Terminal) is placed in the core room. ONU (Optical Network Unit) is placed in the customer room. OBD (Optical Branching Device) is placed in the access room.

EPON belongs to the IEEE802.3 protocol family. EPON can transport 1518 bytes (maximum). The uplink and downlink transport technology of EPON is difference. The downlink transport technology of EPON is shown in Figure 2.

The downlink transport technology of EPON uses TDM technology. The wavelength of downlink is 1490 nm. TDM stands for Time Division Multplexing. According to the IEEE 802.3ah protocol, each frame header contains a special ONU logical link identifier, this is allocated when the ONU registers. The identifier indicates that this frame is transmitted to a special ONU. As shown in the Figure 2, the OLT transmits several frames to the OBD through the broadcast way. These frames are copied three times, every copy contains whole frames. When the copy comes into the ONU, the ONU will receive and transmit matched frames, drop the unmatched frames according to compare the frame logical link identifier with the ONU logical link identifier. For example, in the ONU1 the frame one is transmitted, the frame two and frame three are dropped, the frames are transmitted in chronological sequence.

The uplink transport technology of EPON is shown in Figure 3.

The uplink transport technology of EPON uses TDMA technology. The wavelength of uplink is 1310 nm. TDMA stands for Time Division Multplexing Access. The network bandwidth of EPON is the quantity of the basic time slot for transmission of data. A basic time slot is 16ns. The time of the PON interface between the OLT and the ONU is strictly synchronous. The OLT assigns a certain quantity of basic time slots for every ONU. The OLT sets the time when starts transmission. Every ONU only can transfer data frames to the OLT in the assigned time by the OLT. The time slot assignment and time delay compensation can ensure the uplink data frames without conflict, when the uplink data frames of several ONUs use an optical fiber for transporting data to the OLT. The data frames are transported through the OBD.

2.2 *Network architecture*

According to the different placement of the ONU, the architecture of EPON generally can be divided into several patterns: FTTH/FTTO, FTTB and so on.

FTTH stands for Fiber to the Home. FTTO stands for Fiber to the Office. The architecture of FTTH /FTTO is uniform. As shown in the Figure 4, OLT (Optical Line Terminal) is placed in the core

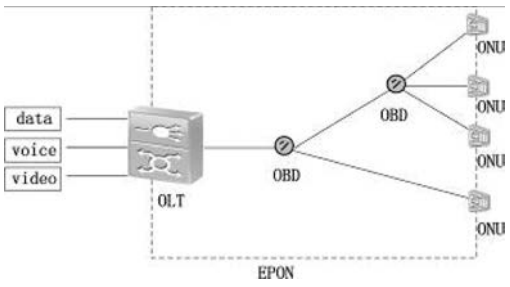

Figure 1. The network structure of EPON.

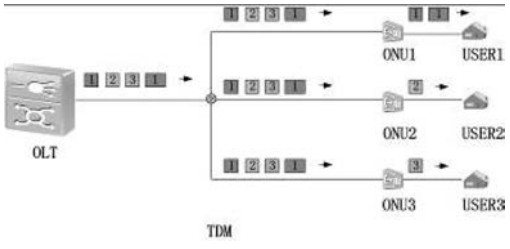

Figure 2. The downlink transport technology of EPON.

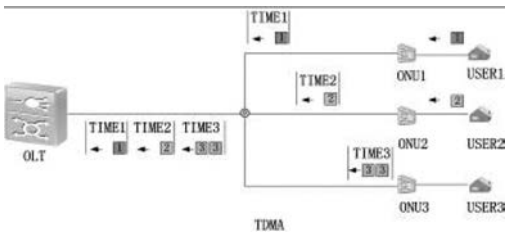

Figure 3. The uplink transport technology of EPON.

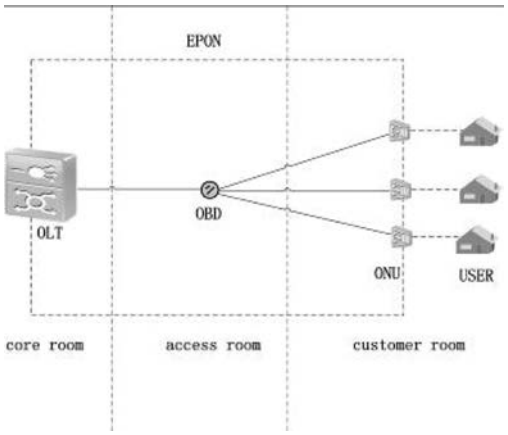

Figure 4. The architecture of FTTH/FTTO.

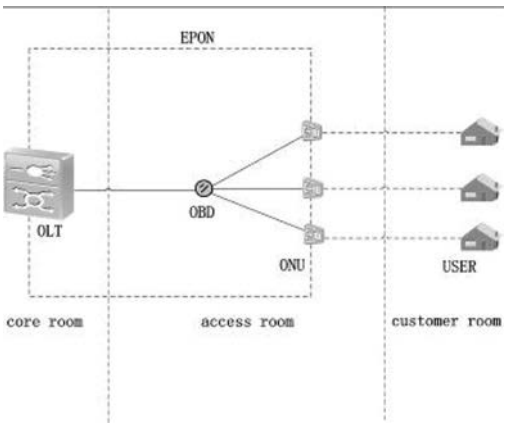

Figure 5. The architecture of FTTB.

room, OBD (Optical Branching Device) is placed in the access room, ONU (Optical Network Unit) is placed in the customer room.

FTTB stands for Fiber to the Building. As shown in the Figure 5, OLT (Optical Line Terminal) is placed in the core room, OBD (Optical Branching Device) and ONU (Optical Network Unit) are placed in the access room. The connect between the ONU and customers can use several cables such as telephone line, twisted pair cable, coaxial cable and so on.

2.3 *Advantage*

The advantage of EPON is mainly shown in the following aspects:

1. EPON can provide the 1.25 Gbps symmetrical bandwidth of the uplink and downlink. In the feature GPON can support to provide 2.5 Gbps symmetrical bandwidth.
2. The topology of EPON is a point-to-multipoint network topology. EPON can cover a lot of territory.

   Each OLT can insert several pon interface cards.

   Each pon interface card assembles many pon interfaces. Each pon interface can connect 64 ONUs at most. So each OLT can connect a lot of customers.
3. The EPON link between the OLT and ONU only has passive equipment. This network architecture can reduce the costs of operation, administration, maintenance and construction.
4. Because the modularization of EPON is a high level and has strong expansibility, EPON can protect the prophase investment well.

3 SCHEME

3.1 *Present condition*

As shown in the Figure 6. Shanghai government external access network (ETHERNET) contains core room, access room, customer room. The equipments of core room contain a core PE, two transparent firewalls, a core convergence network switch. The equipment of access room contains an access network switch. The equipment of customer room contains a customer network switch.

Shanghai government external network contains almost 40 core rooms, 200 access rooms now.

3.2 *Scheme*

In the city, the OLT is placed in the core room. The OLT connects the PE and OBD. The 1:8 OBD is placed in the access room. The OBD connects

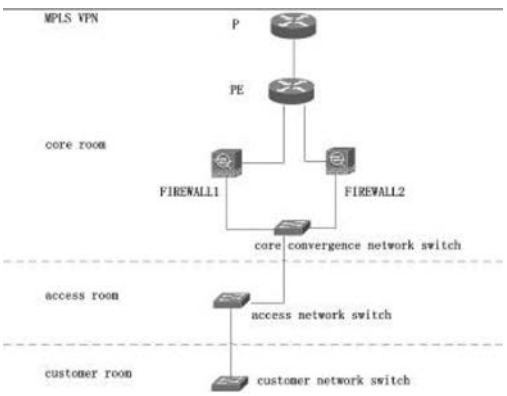

Figure 6. The architecture of access network.

the OLT and ONU. The ONU is placed in the customer room. As shown in the Figure 7.

In the suburban district, some OLTs are placed in the access room because the distance between core room and customer room exceeds 20 KM. So it should increase the core convergence network switch. The switch is placed in the core room. The switch connects the PE and OLT. So there are two network architectures. As shown in the Figure 8.

1. The OLT that is placed in the core room connects the core convergence network switch and OBD. The 1:4 OBD is placed in the access room.

   The OBD connects the OLT and ONU. The ONU is placed in the customer room.
2. The OLT that is placed in the access room connects the core convergence network switch and OBD. The 1:4 OBD is placed in the access room. The OBD connects the OLT and ONU. The ONU is placed in the customer room.

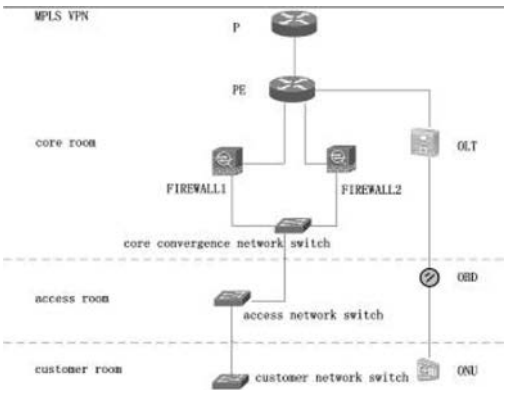

Figure 7. The architecture of central EPON network.

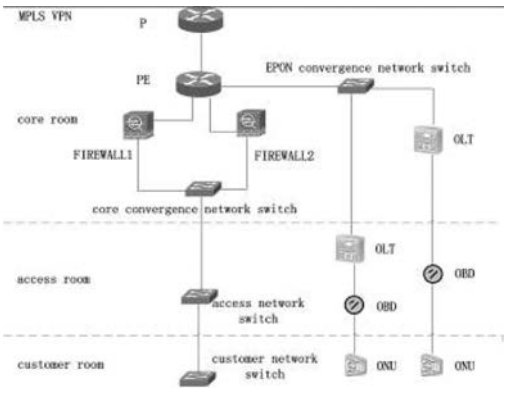

Figure 8. The architecture of suburban EPON network.

3.3 *Resources plan*

3.3.1 *VLAN*

The plan of VLAN is shown in Table 1.

3.3.2 *Management*

1. The 37 C IP address segments are allocated to EPON management.
2. The management IP address segment is 10.X.238.0/24. VLAN is X+10.
3. The management address is configured in the PE. It notifies under the ISIS protocol.
4. The management IP address of OLT is 10.X.238.2. The management IP address of PE is 10.X.238.1. The management IP address of ONU is 10.X.238.10–254.

   * X is room number.

3.3.3 *Olt interface*

The OLT must configure uniformly. The configuration rule of the OLT interface is planned according to the Oriental Cable Network IP and interface rule.

1. The number 1 PON interface starts to use for the downlink PON interface. The number 11 and 12 interface are reservation PON interface.
2. The patterns of uplink ethernet interface and downlink PON interface are trunk.
3. The PON interface configures the registration pattern of ONU.

3.3.4 *Onu interface*

The ONU must configure uniformly. The configuration rule of the ONU interface is planned according to the Oriental Cable Network IP and interface rule.

1. The video service uses number 1 ethernet interface. The vdi service uses number 2 ethernet interface. The gov backup service uses number 3 ethernet interface. The internet backup service uses number 4 ethernet interface. The number 7 and 8 interface are reservation ethernet interface.
2. The pattern of uplink PON interface is trunk.

Table 1. The plan of VLAN.

Service	ONU (CVLAN)	OLT (SVLAN)
Video	1501–2000	1501–2000
Vdi	2001–2500	2001–2500
Backup	Used VLAN	Used VLAN
Management	Allocated VLAN	Allocated VLAN
Reserve	1–200	1–200

3. The pattern of downlink ethernet interface is access and nonegotiation.

4 CONCLUSION

Oriental Cable Network Co. Ltd will increase the development of the Shanghai government external network. The EPON link will provide a redundancy backup network link for the government external network.

The EPON link will enlarge the government external access network. The EPON link will carry more government external network service. We can avoid some network problems and carry more services through building the EPON link:

1. The access room powerless or damaged access network switch.
2. Video network service.
3. Vdi service.
4. Backup network link.

REFERENCE

Haoran Huang, Ling Gong. 2004. The ip address and interface plan of Oriental Cable Network.

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The study of CFD on aerodynamic characteristics of freestyle skiing athletes in the curve slideway period

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ABSTRACT: In order to explore the aerodynamic characteristics of athletes in the aerials event of freestyle skiing sliding on the platform, to provide aerodynamic parameters for the calculation on leaving platform speed, the essay makes use of the CFD method to study on aerodynamic characteristics of Chinese freestyle skier Mengtao Xu in the curve slideway period. The results show that: The lift of athletes in the curve slideway period can be neglected, and the resistance can't be neglected because it is relatively large. With the common superposition of resistance and own gravitational tangential component, the athletes sliding speed will decay rapidly. In addition, to improve the stability of athletes' movements on leaving platform, athletes should try to keep away from the eddy zone formed by the slope on leaving platform and the angle area of the vertical wall.

Keywords: freestyle skiing aerials; curve slideway; lift; resistance; CFD

1 GENERAL INTRODUCTION

Aerials of freestyle skiing is the Winter Olympics standing event. Xiaopeng Han, Chinese athlete won the gold medal of the event in the 20th Turin Winter Olympics and achieve the gold medal zero breakthrough about snow events in history of the Winter Olympics. Aerial of freestyle skiing is composed of slipping, taking off, launching turn and falling to the ground. In the game, athletes take off from the height of about 4 m platform and complete a series of turn in falling process after launching the height of about 15 m and finally land in 37° slope stably. The granding of freestyle skiing aerials is mainly based on the completed quality of launching turn and landing phase. So the related research both here and abroad more concentrated upon the launching turn and landing phase and there is little attention to slipping and taking off phase. A perfect taking off can provide enough launching height and stability for completing launching and turn and slipping stage is the key to guarantee the perfect taking off. In slipping stage, athletes will shift their position from stances like horse riding step to jumping position, straighted up arms and the body upright. As shown in Figure 1 (in the curve slideway, athletes basically keep the position shown in Fig. 2). It plays an important role in completion a high-quality taking off to control slipping phase, especially the aerodynamic characteristics in the curve slideway period. There is not detailed study reports here and abroad because of the bad environment, experimental means and testing technology limited. With the rapid development of computer hardware and software technology, CFD has become comeplex fluid flows, even the main methods and means of study on the fliud-structure heat and mass transfer. In this essay, adopt the concepts and methods of CFD to study the aerodynamic characteristics of

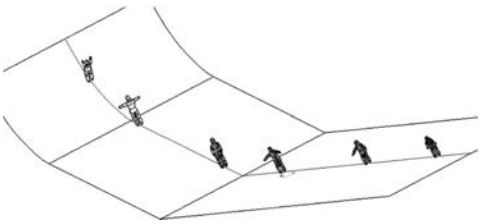

Figure 1. Athletes posture slideway evolution diagram.

Figure 2. Athletes physical model.

Chinese freestyle skiing aerials athletes in the curve slideway period, so it will reach a basis for simulating of motion process of athletes slipping stage.

2 ATHLETES THREE-DIMENSIONAL ENTITY MODEL AND CFD MODEL

Athletes' materialization model has been restricting the freestyle skiing slip stage the bottleneck of the aerodynamic characteristics for CFD study. According to the theory of reverse modeling, the Application of Laser Scanning Technology Mengtao Xu in the Three-dimensional Human Body Model in our country (the windward surface projection area of athletes is 0.676935 m^2), get up to more than 20 points of point cloud data, In the 3D design software integrated by small plane modeling, to repair the broken surface and materialization process set up the three-dimensional entity model of the athletes (Athletes surface is divided into 87 seamless connection surface). As shown in Figure 2.

The freestyle skiing slope is consisted by plummeting, straight and curve segments. The curve equation of curve segment is little detailed reported in the literature at home and abroad. According to the measured results by polynomial fitting to get the help of ramp curve equation for the curve segment:

$$y = a_1 + a_2 x + a_3 x^2 + a_4 x^3 + a_5 x^4 + a_6 x^5$$

Type in:

$$a_1 = 0;\ a_2 = 4.4 \times 10^{-2};\ a_3 = 1.3 \times 10^{-5};$$

$$a_4 = 5.4 \times 10^{-8};\ a_5 = -1.6 \times 10^{-11};\ a_6 = 1.6 \times 10^{-15}$$

Finally, using 3D design of insert/merge and inheritance function module, the space model of athletes about the flow field around was established (for save computational cost, in addition to the ways of plummeting). Seen from Figure 3, slide for the athletes to the section curve of 6.752 m at the time of the flow field around the space model (point of curvature radius of 3.09 m, at that point slide tangent plane and horizontal plane Angle is 117.291°).

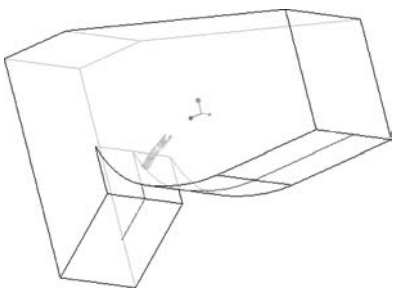

Figure 3. CFD computing model.

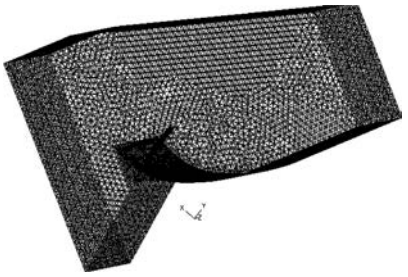

Figure 4. Schematic diagram of grid division.

3 CFD SIMULATION RESEARCH

The air power is applied to the pressure and friction force of athletes, the resultant force can be obtained by solving the flow field around a athletes. Because of the complicated shape and large athletes sliding speed, so the flow field around the athletes will be for the turbulent flow field. In a variety of turbulence model chose k—ωSST turbulence model, the finite element method to solve the turbulence model equations. Seen from Figure 3 and Figure 4, the flow field around a space model of meshing (more than 320000 is divided into four nodes tetrahedron element) after the meshing diagram. Considering the close to the player within the boundary layer on the surface of the larger velocity gradient and the uneven surface of the athletes, meshing specially in athletes encryption on the surface of the grid. Athletes in the program and ski slopes were defined as not penetrate the surface of the wall (including athletes for mobile wall surface), the rest of the surface is the surface of the open (consistent with the actual). Assumes that the environment temperature is –20°, the air density and dynamic viscosity were 1.395 kg/m^3, 1.62 × 10^{-5} Pa·s. And the difference of linear slide athletes in the translation is that in the curve track athletes are turning around its instantaneous center. The instantaneous center is changing the curvature of the curve track centre.

4 RESULTS AND ANALYSIS

The circle flow field around an athlete was calculated at the angular velocity of 6, 7, 8, 9, 10, 11, 12 degrees/sec. Figure 5 shows the number of longitudinal profile velocity distribution when the

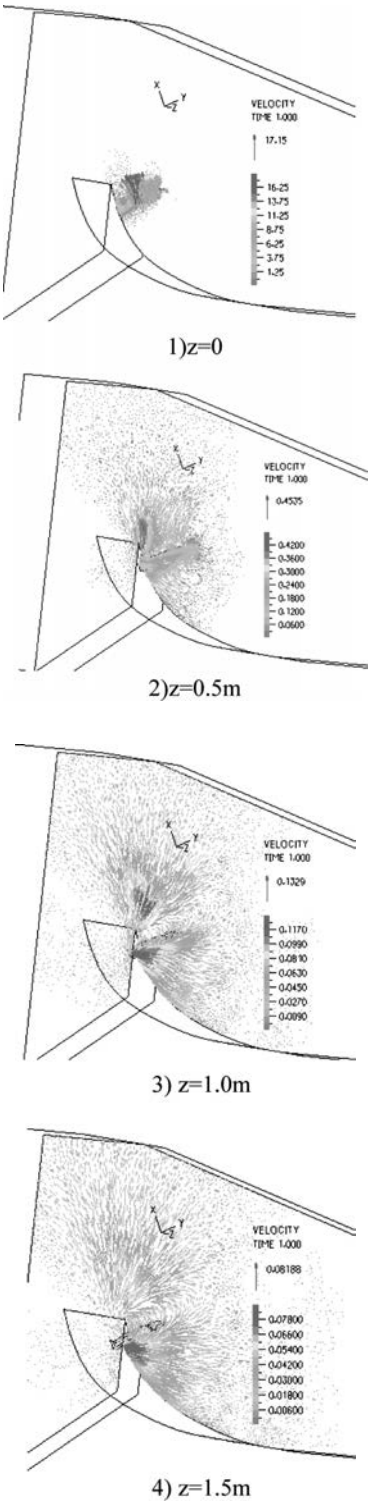

Figure 5. Longitudinal velocity vector diagram.

angular speed of 8 degrees/sec (where the longitudinal profile of $z = 0$ and athletes' median coincide plane sagittally).

Seen from Figure 5, velocity distribution in each longitudinal profile showed a non-uniform characteristics, although athletes' sliding speed is large, the walls except snow road are open, so that the air volume flow rate that the athletes taking around are minimal in terms of sliding speed. When the athletes near the end of the chute, influenced by player driven, it will form air flowing in the same direction with athletes' sliding speed in the region of a space that athletes will participate in and form eddy current in the upcoming slopes and Angular domain vertical walls.

Figure 6 and Figure 7 shows the curves equations which are about the relationship between athletes lift and drag obtained by polynomial fitting and the sliding speed.

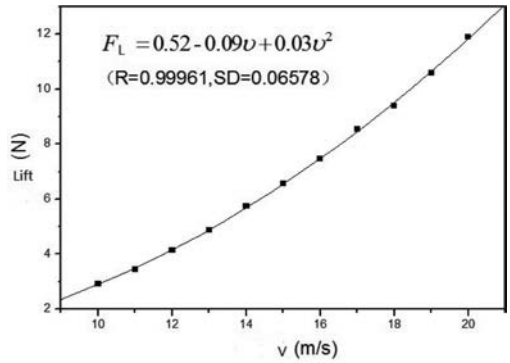

Figure 6. Curve and equation between lift and sliding velocity.

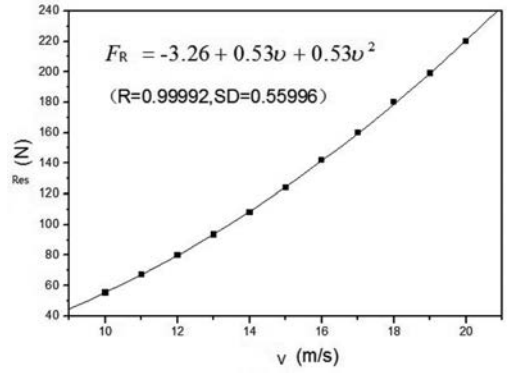

Figure 7. Curve and equation between resistance and sliding velocity.
(Note: Figures 6 and 7 in the R correlation coefficient, SD as the standard deviation of the fit).

Seen from Figures 6 and 7, both lift and drag sliding velocity increases as the athletes and nonlinearly increases, the curve is concave, and therefore with the sliding speed increases athlete, increased lift and drag, the faster the lift resistance is concerned than an order of magnitude smaller. athletes slide to the area, if the sliding speed of 20 m/s, from Figures 6 and 7 shows, drag and lift of approximately 220 N and 12 N, at which point its own gravity (with the securing fitting) of the tangential and normal components of approximately 548 N and 283.07 N. Visible, lift compared to the component itself in terms of gravity was much smaller, so that the lift can be ignored. The friction between the skis and the slide is mainly due to the component of gravity and centrifugal force caused. Resistance is the tangential component of gravity rather, a strong air resistance and gravity tangential component of the double effects, athletes tangential acceleration up –12.2 m/s, so athletes slide sliding speed at the end of the curve will decreased rapidly.

5 CONCLUSION

According to the theory of the reverse modeling, based on the created entity model of freestyle skiing aerials in the curve slideway period, we have created the space model of flow field within 3D virtual design software and simulated the there were effectives in study on the aerodynamic characteristics of freestyle skiing aerials slipping phase with CFD. The results show that: Athletes should try to keep away from the eddy zone formed by the slope on leaving platform and the angle area of the vertical wall and made against the satability of athletes' movements on leaving platform. At the end of the curve slideway, the influence of friction between skateboard and slideway by lift could be neglected. The air resistance is similar to own gravitational tangential component, so it will have a large tangential acceleration and sliding speed will decay rapidly. If athletes want an enough leaving platform speed, besides raising the starting height properly, still need to try to reduce own weight and frount face area.

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Kinematic comparative study of technical actions of backhand chop of table tennis and tennis

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ABSTRACT: In order to specify the kinematical characteristics of backhand chop in table tennis and tennis and to provide a large number of quantitative scientific basis for teaching and training, this paper tries to use the three-dimensional photography analytical method to get the kinematic parameters of high-pressure tennis action and deals with these data statistically. The study shows: table tennis backhand chop has to overcome small resistance. The action is reflexible with rapid immobilization while tennis backhand chop has to overcome greater resistance. Improving the speed of backhand chop is realized by increasing the turning radius and thereby increasing the distance of the acting, in another word "hitting by borrowing power". The action is relatively fixed because of the slow joint movement.

Keywords: table tennis; tennis; backhand chop skill; kinematics

1 INTRODUCTION

Technology of backhand chop is one of the attacking skills which has the characteristics of great power, fast speed and requiring a short period of landing.[1,2] Good Technology o backhand chop will help to gain the most effective scores and to win the match. Most of the researches are centered on the summary of experience. They have no quantified scientific description.[3–6] In recent years, with the application of the high speed video analysis technology in analyzing sport skills,[8] it provides a scientific method for the quantified analysis of tennis skills.[9] This study can help the teachers in comprehensive universities and colleges and students who participate in sports understand more about the action of backhand chop, and help teachers to guide correctly in the teaching practice. In the teaching practice, the students have basic knowledge about one of the event knowing what they can share and how to treat them differently in practising anther event, which can promote the rapid development of sports teaching practice.

2 RESEARCH SUBJECT AND METHODS

2.1 *Research subject*

The thesis focuses on ten elite professional athletes of table tennis and tennis in provincial team whose athletic careers are of at least two or more years. The athletes all hold the rackets by right hand and all the research targets are centered on the joints of the right hands.

2.2 *Research methods*

The researching equipments include two Sony video-cameras with the same standard and the shooting frequency of 125 Hz/s, a three-dimensional DLT radiate frame, two photography lights and two personal computers. The two video-cameras are placed respectively to the left side of the athlete in front and the horizontal front for the purpose of recording the overall movements completely. The main axis of the two cameras is of 90 degree. The data obtained from the SPAS system will be dealt with Excel, and the kinematic data of backhand chop of table tennis player and tennis player provide evidence for the future theory analysis.

3 RESULTS AND ANALYSIS

3.1 *Analysis of the lower limbs' movements*

3.1.1 *Hip joint movement*

As is shown in Figure 1, compared with tennis player, hip joint speed of table tennis player is small with great changes; On the comparison of the angle of hip joint, there is small change in both table tennis and tennis. The hip joint angles of table tennis and tennis decrease in the stage of foreward swing, but from the stage of swinging racket to

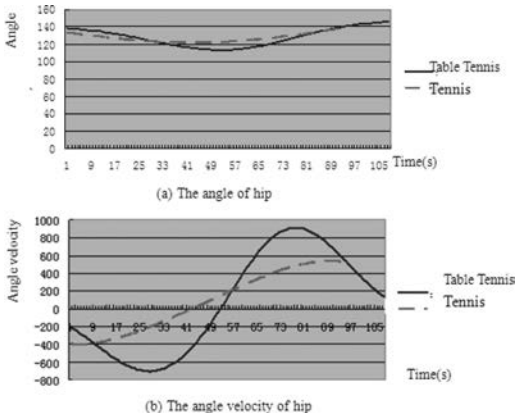

Figure 1. The curve change of each hip joint variable.

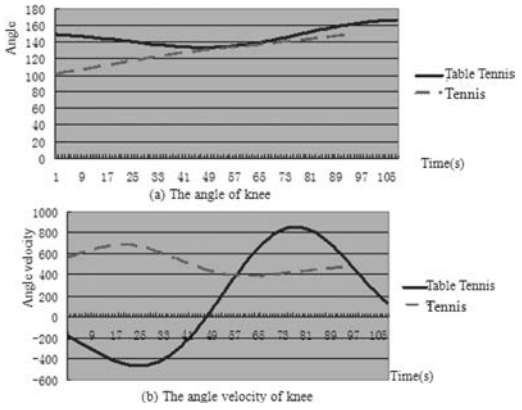

Figure 2. The curve change of each knee variable.

meet the ball to the stage of touching the ball with the racket, the hip joint angle of table tennis are more changeable than tennis. During this stage, the decrease of hip joint angle may make the ball hit more stable. However, because tennis players have to overcome relatively greater resistance, the angle of hip joint is not easy to change.

3.1.2 *Knee movement*

From Figure 2 we know that there are changes in each variable of knee and the change of knee angle is smallest in the process of backhand chop of table tennis and tennis. According to this research, when the scope of knee angle is from 75 ° to 150 °, the kicking strength of knee increases with the increase of the knee angle; When knee angle is greater than 150 °, the kicking strength of knee decreases with the increase of the angle. When table tennis and tennis players take the action of backhand chop, the knee angle is always less than 150 °. The knee angle is more than 150 ° only in the stage of swinging the racket to hit the ball, which indicates that the knee is within the best range of kicking strength of knee when table tennis and tennis players take the action of backhand chop.

3.1.3 *Ankle movement*

Figure 3 shows that there are great changes of each ankle variable in the process of table tennis and tennis backhand chop, in which the change of ankle joint angle is smallest. In the whole process of hitting balls, the change of the curve of ankle angle in playing table tennis and tennis is consistent within a range of about 10 °, which shows that the ankle is relatively fixed. In the entire process of the movement, the ankle angle of table tennis is obviously greater than the ankle angle of tennis, and the change of ankle angular velocity in table tennis is more obvious than tennis's, which indicates that in the process of backhand chop of table tennis and tennis, the movement radius of ankle of table tennis is larger than tennis's.

3.2 *Analysis of upper limbs' movements*

3.2.1 *Shoulder movement*

From Figure 4 we know that in the process of backhand chop, the initial speed of shoulder joint in tennis was significantly greater than the initial speed of shoulder in table tennis. The decline rate of the speed of shoulder in tennis is slow and relatively stable, but the speed of shoulder in table tennis has large fluctuations in the whole downward trend. The changes of the shoulder angle in table tennis and tennis are similar. The shoulder angle of tennis is smaller than table tennis's with a small variation range. There are large fluctuations in the whole hitting process, while the angular velocity of

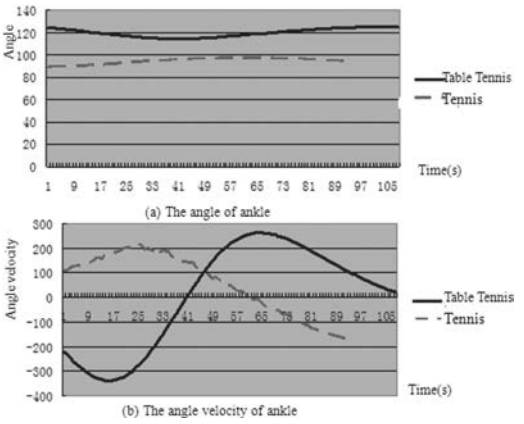

Figure 3. The curve change of each ankle variable.

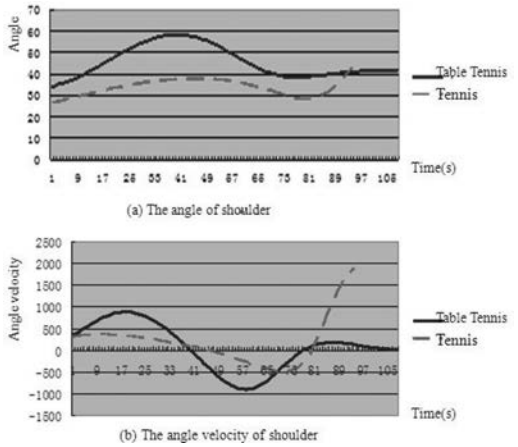

Figure 4. The curve change of each shoulder joint variable.

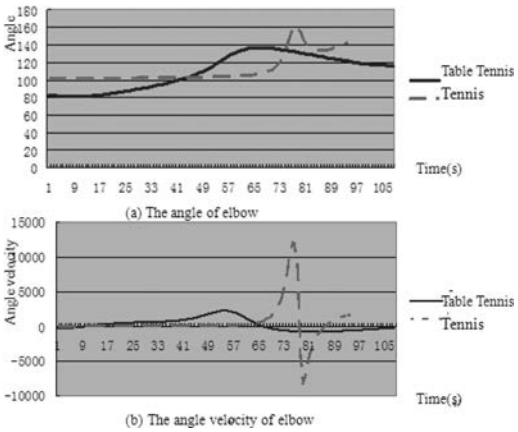

Figure 5. The curve change of each elbow variable.

shoulder joint in tennis increases rapidly after the racket contact the ball.

3.2.2 *Elbow movement*

From Figure 5 we know in the stage of forward swing in table tennis and tennis backhand chop, there are changes in the speed of table tennis athlete's elbow. The angle increases but the angular velocity of the elbow remains relatively stable. From the stage of forward swing to meet ball to the stage of touching the ball with the racket, the elbow speed increases from a low point rapidly, while the angle and the angular velocity increase. In the stage of backswing, the speed of the elbow rapidly decreases to the lowest point, while the angle has a slight decrease and the angular velocity gradually returns to the previous state. While in the stage of forward swing, there is almost no change in the tennis player's elbow speed as well as angle and angular velocity. From the stage of swingnig the racket to meet the ball to the stage of touching the ball with the racket, the speed of the elbow increases gradually. The angle remains the same, but increases rapidly at the moment of hitting the ball, and the angular velocity increases at the moment. During the stage of backswing, elbow speed increases slowly and the angle decreases together with the gradual return of angular velocity to the state of the stage of forward swing. The differences of curve changes during the stage of foreward swing are the results of the different intensity of force from shoulder joint in these two sports events. So table tennis player's elbow varies a lot with a relative flexibility. while at this stage tennis player is accumulating energy, and the elbow is relatively stable. During this stage, the increase of the speed of tennis player's elbow is less faster than that of the table tennis's, which indicates the elbow in tennis backhand chop is less flexible than that of the table tennis's. Due to the different force intensity from shoulder joint in these two sports events, the elbow speed, angle and angular velocity of table tennis player decrease rapidly after contacting the ball in the backswing, and return to the previous state immediately. However, the angle and strength of arm swinging after contacting the ball will decrease gradually by moving with the shoulder for a while.

3.2.3 *Wrist movement*

Figure 6 shows that in the stage of forward swing of table tennis backhand chop, there exists variation of athlete's wrist speed. The angle decreases and the angular velocity remains relatively stable.

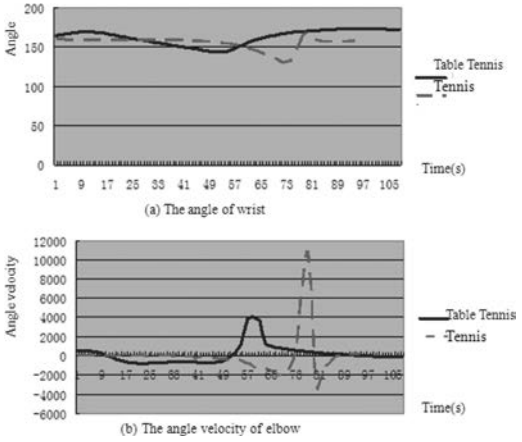

Figure 6. The curve change of each twist variable.

In the stage of swinging the racket to contact the ball with the racket, wrist speed rapidly increases from the low point, while the angle increases slightly and angular velocity reaches the peak. In the stage of swingning the racket after hitting a ball, the speed of the wrist decreases quickly to the lowest, while angular decreases lightly and angular velocity gradually returns to the state of the stage of forward swing. Tennis player's wrist does not change in the stage of forward swing, which remains at a relative low level and angle and angular velocity almost have no change. In the stage of swinging the racket to contact the ball with the racket, the speed of the wrist increases gradually, and the angle decreases. However, the angle increases rapidly in the moment of touching the ball and the angular velocity also increases rapidly at the same time. In the stage of swingning the racket after hitting a ball, wrist speed increases slowly, while the angle decreases and the angular velocity gradually returns to the state of the stage of forward swing.

4 CONCLUSION AND SUGGESTIONS

4.1 *Conclusion*

From the stage of foreward swing to the stage of swinging the racket, the resistance of table tennis backhand chop is small, while the action is flexible and the immobilization of joint is rapid. Therefore, players have to produce force by coordinating each joint in the hitting process.

Because the resistance in the process of hitting tennis is large, improving shotting speed of tennis backhand chop is achieved by increasing the turning radius and thereby increasing the distance of the acting, namely "hitting by borrowing power". The action is relatively fixed because the movement of joints is slow.

In the process of backhand chop in table tennis and tennis, the angle of the knee joint is always less than 150 °, which is within the best range of kicking strength; The ankle angle curve variation is consistent in the process of backhand chop of table tennis and tennis within a range of about 10 °.

For the sense of keeping gravity, backhand chop of table tennis can only consider the relative contents about hitting rate, without haing to consider the effects from the racket to the ball and effects from the player's body to the ball; However, tennis backhand chop must take the processing of the ball momentum into account, and in the process of tennis backhand chop we must "first withstand and then turn body", that's to say, turning our body after withstanding the momentum from the ball.

4.2 *Suggestions*

In teaching and training technical actions of table tennis backhand chop, we should emphasize and strengthen the strength training of all aspects of body muscle and the ability of coordinating each joint of our body.

In teaching and training technical actions of tennis backhand chop, based on the conventional action essentials, all joints are relatively fixed, and improving the ball's hitting quality is achieved by increasing the turning radius.

In teaching and training table tennis and tennis, we have to strengthen the strength training of players' joints and their coordination so as to increase energy transferring effects. In tennis teaching and training, we should improve the processing of the momentum from the ball and avoid the overlapping of teaching and trainning both table tennis and tennis before have an intimate knowledge of one of the two sports events.

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The kinematics analysis on throwing ability of 2–6 years old healthy infants

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ABSTRACT: By 2-d camera and video analytical method, 3 to 5 years old healthy children throwing action feature points age, points are analyzed, and compared gender six months after its action characteristic changing circumstances. Through the analysis in the process of throwing mastery of upper limb movement structures and the Angle of each joint of each phase of change and finish the time needed for changes, and points out that the healthy children throwing movement characteristics and development law, as a child in the growth process of development and promote cheeper action to provide theoretical basis for healthy growth.

Keywords: children; throwing; biomechanics; kinematics analysis

1 GENERAL INTRODUCTION

Throwing is a very difficult action which needs the coordination of many parts of the body. Throwing ability is of great value in infants' daily life, work and physical activities. So it is significant to observe infants' development in throwing action as well as its development patterns.[1–3] Research on human's throwing action by far for the purpose of improving competitive sport performance such as shout put, hammer throw and javelin. Other research concerning average healthy infants focused on the value of games to the development of infants' throwing ability.[4–6] Rarely is there any research or documents monitoring infants' structure of throwing action, changes of joint angle of different phase and the maturity of action from the aspect of sport biomechanics. This paper is based on sport biomechanics and conducts technical analysis on infants' throwing action by means of video analysis. The study focuses on the feature difference and development pattern of body movement of different age and gender, so as to lay a foundation for the evaluation of the development level of infants and provide proper guide and method for the development of infants' throwing ability.

2 RESEARCH SUBJECTS AND METHODS

2.1 *Research subject*

From Dec 2010 to Feb 2011, Video clips were captured among children aged 1–6 in Donghu Kindergarten, Kindergarten attached to Liaoning Provincial Committee and Montessori Early Education Center. Children were grouped with the age gap of half a year and there are about 50 members in each group. According to the age feature of the development of children's big movement, children aged from 2 to 6 were videotaped their throwing in 8 groups, see Table 1.

2.2 *Research method*

Sony video cameras (50 Hz sample rate) were used to shoot infants' throwing a tennis ball from the side. A one-meter square scale was used for camera calibration. Camera at the side divides the action

Table 1. Groups of subjects.

Age group (year)	Group 1 2.0–2.5	Group 2 2.5–3.0	Group 3 3.0–3.5	Group 4 3.5–4	Group 5 4.0–4.5	Group 6 4.5–4	Group 7 5.0–5.5	Group 8 5.5–6
N (person)	20	27	50	50	50	50	50	50
Av. height (cm)	89.34	95.62	100.02	103.37	106.98	110.59	113.90	116.03
SD (cm)	6.02	5.02	5.02	4.20	4.76	5.28	5.34	4.90

into phases and obtains indices of joint angle change of the subjects with a calibration error less than 0.5 mm. DV tracker was employed to analyze these videos and configure physical quantity to be analyzed. Matsui Hideji's 15-link model was adopted and 21 tracking points were used to calculate human gravity center. The measured data were processed with five-spot e smoothing method. Spss13.0 was used to process data, and the data were presented with ($\overline{x} \pm s$), Independent Samples T-test was employed to compare the two groups, $P < 0.05$ means significant difference and $P < 0.01$ indicates rather significant difference.

3 RESEARCH RESULT AND ANALYSIS

3.1 *Phases of throwing action*

As one of the basic physical movements of healthy people, throwing action can be seen both in daily life and sport activities. The completion of the movement needs the coordinative cooperation of upper body, trunk and lower body. A standard throwing action can be divided into initial posture phase, rotation and arm-raising phase, final pitch phase and buffer phase[7] as follows:

Initial Posture Phase: Spread fingers naturally, put the ball on the root of fore finger, middle finger and ring finger, with sum and small finger holding the ball to prevent sliding as well as to control the ball. The palm does not contact the ball. When this is done, the left side body faces the direction of throwing, with two feet separating a little wider than shoulder, left toe tip pointing oblique front and being on the same line with right foot arch.

Rotation and Arm-Raising Phrase: Bend right knee, trunk and shoulder lean and rotate to right, gravity center rests on right leg; bend left arm lightly to chest and thus the ball's vertical point falls outside tight foot to extend pitch distance and tighten muscle on the left.

Final Pitch Phrase: Kick the ground forcefully with right foot, raise heel, turn right knee inward, push right hip forward, raise the upper body to the left and rotate to the pitch direction. When the left body is close to be vertical to the ground, straighten right leg with left shoulder as an axis, body turns to throwing direction, raise head and chest with right shoulder pushing forward forcibly, right arm straighten quickly and push the ball forward with angle of 40–42 degrees. Snap wrist when the ball leaves hand and push the ball with hand. In the meantime, straighten left leg upward to push the ball upward and forward.

Buffer Phase: Right leg switches quickly with left foot after the ball leaves, left leg moves backward to lower gravity center and buffer the momentum forward and keeps balance.

Children's body is not well developed, their muscles are less coordinative and what's more, they are not professionally trained, so they take a natural posture of throwing. In the beginning their postures are not standard, they just split their feet sideways. There are not obvious trunk rotation and buffer phases or there are none at all. So the research mainly focuses on the joint angle and development pattern of arm-raising and final pitch phase as well as the rotation of children and the time of action completion.

3.2 *Kinematics analysis on throwing action*

From Table 2 we can see that there is no significant difference among children of different genders. It is found during data processing that the difference

Table 2. Angular change of shoulder and elbow joints of different age groups after arm-raising.

	Angular change of shoulder joint (degree)		Angular change of elbow joint (degree)	
Subject	Male	Female	Male	Female
Group 1	118.20 ± 11.38	123.60 ± 9.09	61.96 ± 10.81	58.74 ± 32.31
Group 2	120.11 ± 13.85	125.37 ± 32.57	63.89 ± 36.68	60.66 ± 27.88
Group 3	121.84 ± 29.72	126.46 ± 24.99	64.91 ± 5.62	61.48 ± 37.83
Group 4	127.36 ± 24.68	131.84 ± 23.67	66.95 ± 41.99	62.05 ± 31.72
Group 5	132.66 ± 13.91	135.29 ± 21.98	70.96 ± 39.83	64.63 ± 23.10
Group 6	144.15 ± 25.41*	143.03 ± 20.13*	87.09 ± 43.07*	80.65 ± 22.83*
Group 7	148.16 ± 32.01	155.57 ± 27.26*	88.65 ± 30.00*	91.43 ± 36.70**
Group 8	156. ± 24.27*	162.03 ± 18.85*	111.54 ± 22.41*	110.48 ± 32.43*

Note: Data is presented as Average value ± SD, *: means the difference is significant at 0.05, **: means the difference is significant at 0.01, the same below.

in writ angle is statistically insignificant, whereas the difference between shoulder and elbow joints is statistically significant. So the research mainly studies the change of shoulder and elbow joints during final pitch and the time needed among different age groups.

3.2.1 *Angular change of shoulder and elbow joints in arm-raising phrase*

Spss was used to conduct an One-way ANOVA of the data which shows that there is no significant difference of shoulder and elbow joint angle during arm-raising for children of 3–4 years old. Difference of shoulder and elbow joint angle during arm-raising for children of 4–5 years old begins to be significant and the angle is obviously larger. Analysis shows that the shoulder and elbow joint angle increases as age grows, the older, the larger increase of the angle. This is an indication of body maturity. The wider spreading of shoulder and elbow help increase the distance of power exerting, the longer the muscles stretch, the more elasticity produced, and is released in final pitch. This increases body's work on the object and increase the object's speed when leaving the hand.[7]

3.2.2 *Angular change of shoulder and elbow joints in final pitch phase*

One-way ANOVA was conducted and results shows that significant difference of shoulder and elbow joint angle during final pitch for children of 3–4 years old. Difference of shoulder and elbow joint angle in final pitch phase for children of 4–5 years old begins to be significant and the angle is obviously larger. Analysis shows that the shoulder and elbow joint angle increases as age grows, the older, the larger increase of the angle. This is an again the indication of body maturity. Larger shoulder and elbow joint angle can increase the distance of the object away from the body and increase pitch distance.[7] In addition, it can increase the time that muscles work on the object and increase the object's kinetic energy.

3.2.3 *Wrist angle when object leaves the hand*

Seen from Table 4, children' wrist angle is obviously less than 180 degree when the object leaves the hand. This means children unconsciously turn their wrists downward. This reduces the flight height and time of the object and shortens the pitch distance of the object. The degree of turning wrist downward reduces as age grows, the throwing

Table 3. Angular change of shoulder and elbow joints in final pitch phase.

	Angular change of shoulder joint (degree)		Angular change of elbow joint (degree)	
Subject	Male	Female	Male	Female
Group 1	113.32 ± 29.22	116.09 ± 22.01	138.71 ± 13.25	128.91 ± 9.67
Group 2	116.35 ± 20.38	114.63 ± 11.64	138.99 ±13.67	131.84 ± 31.61
Group 3	121.71 ± 23.45	118.99 ± 36.82	145.26 ± 20.49	147.15 ± 23.72
Group 4	120.11 ± 22.07	121.38 ± 31.67	149.06 ± 25.37	150.43 ± 23.2
Group 5	116.02 ± 17.92	127.16 ± 34.86	151.73 ± 39.83	143.94 ± 23.10
Group 6	128.40 ± 14.38**	138.42 ± 20.62*	159.21 ± 25.71	152.38 ± 21.86*
Group 7	137.58 ± 34.73**	135.58 ± 19.10	150.39 ± 14.5*	157.03 ± 17.07
Group 8	149 ± 15.74*	148.54 ± 19.23*	164.58 ± 11.06*	168.60 ± 13.23**

Table 4. Wrist angle when object leaves the hand.

Subject	Male	Female
Group 1	164.67 ± 9.86	155.78 ± 4.34
Group 2	155.42 ± 9.51	156.09 ± 26.79
Group 3	157.96 ± 14.25	156.82 ± 19.95
Group 4	159.81 ± 12.51	165.96 ± 7.90
Group 5	159.46 ± 12.36	156.47 ± 18.85
Group 6	164.22 ± 12.11	160.89 ± 8.45
Group 7	165.98 ± 11.14	166.28 ± 13.27
Group 8	162.94 ± 16.52	168.69 ± 21.57

Table 5. Time needed for throw action.

Subject	Male	Female
Group 1	0.136 ± 0.028	0.143 ± 0.022
Group 2	0.134 ± 0.017	0.143 ± 0.032
Group 3	0.134 ± 0.025	0.142 ± 0.024
Group 4	0.120 ± 0.027*	0.132 ± 0.030*
Group 5	0.122 ± 0.028	0.129 ± 0.040
Group 6	0.112 ± 0.018*	0.127 ± 0.027
Group 7	0.116 ± 0.032	0.113 ± 0.024*
Group 8	0.110 ± 0.024	0.112 ± 0.022

Table 6. Rotation percentage of different age groups.

Subjects	Cases of body rotation		Sample amount		Percentage of body rotation	
	Male	Female	Male	Female	Male	Female
Group 1	0	0	20	25	0%	0%
Group 2	0	0	27	22	0%	0%
Group 3	0	0	28	25	0%	0%
Group 4	2	2	31	32	6.5%	6.3%
Group 5	5	3	28	20	17.9%	15%
Group 6	8	7	35	34	22.9%	20.6%
Group 7	11	10	27	28	40.7%	35.7%
Group 8	14	14	24	33	58.3%	42.4%

action tends to be perfect and the pitch distance increases.

3.2.4 *Time needed for throw action*

Seen from Table 5, the time needed for throwing action reduces when children grow older. Stretching muscles tend to lose power as time extends, the tension power of muscles reduces when stretching a longer time. So the shorter the time needed, the higher efficiency of elasticity, and vice versa.[8] So the shortening of time is also a sign of perfect action performance as well as a sign of the improvement of body coordination.

3.2.5 *Development of body rotation*

There is no body rotation phase for children under 3 years old. The rotation of the trunk appears among children over 4 years old. The leaning back and rotation of the trunk increase the distance of power exerting and increase body's work on the object. The rotation of body also can stretch wait muscles and create elasticity which will work on the object in the final pitch and add more work to the object. From Table 6 we can also see that the ratio of rotation grows with the growth of age. There is no significant difference between male and female children with body rotation phrase, but the ratio of male children is obviously higher than female children when they are over five years old.

4 CONCLUSION

There is no significant difference between development of throwing action of children aged 3–5.

As children grow older, there is the tendency of the increase of arm raising, joint angle of both shoulder and elbow. This is especially obvious in angle increase of back joint of children over 4 years old. The wider spreading of shoulder and elbow help strengthen the elasticity of the upper limb and increase the speed of the thrown object.

There is apparent wrist bending when the object leaves hand, and this bending decrease as age grows. This change can make the parabola cover larger distance and height, and thus the object is thrown further.

As age grows, children need shorter time to finish throwing action. The shortening of the time of muscle stretch reduces consumption of tension makes elasticity transform into kinetic energy more effectively.

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Discussion on the improvement of the effect of 2/3 court zone press defense through court awareness

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ABSTRACT: The tactics of 2/3 court zone press defense is a kind of transformation of the tactics of full-court zone press defense. Inheriting the core content of full-court zone press defense—midcourt attack and positive steals, it is a kind of basketball defensive tactics with aggressive, destructive and strategic nature and relatively good practical application effect. The introduction of court awareness to the tactics of 2/3 court zone press defense can improve the defense effect effectively.

Keywords: court awareness; 2/3 court; zone press; effect

1 PRESENTATION OF QUESTION

As a defensive means commonly used in modern basketball sports, zone press shows the development trend of modern basketball defense. It mainly includes full-court zone press, 3/4 court zone press, 2/3 court zone press and half-court zone press. 2/3 court zone press exists as a kind of middle type defensive means between 3/4 court zone press and half-court zone press. In spite of its conspicuous advantage and reasonableness, as far as court division is concerned, 2/3 court zone press is relatively vague in court concept compared to zone press of other forms. What can make athletes have specific court concept at the court and improve court utilization accordingly? The author holds that it should be court awareness of athletes. Then how can court awareness improve the defense effect of 2/3 court zone press? In view of this, the article makes an in-depth discussion for the purpose of providing reference for theory and application of basketball teaching and training.

2 COURT AWARENESS

2.1 *Concept about court awareness*

Modern basketball coaches attach great importance to "awareness". Here awareness refers to "basketball awareness", "field awareness", "court awareness" and etc. This is individual experience and outward manifestation of athletes' inherent quality through training about modern basketball theory, skills, tactics, psychology and etc. The basketball coach Bremner of University of Nebraska presented the viewpoint about "Court Awareness and Utilization" in his article Twelve Daily Shooting Practice first, which further exposed the relevance between athletes' reasonable application of skills and tactics and court area. Professor Jiang Lijia, Professor Zhang Qiang and Associate Professor Cheng Dongmei of Northeast Normal University published the article "On 'Court Awareness' and Cultivation of Basketball Players" in China Sport Science and Technology in 1996. This was the discussion on the viewpoint about "court awareness" in China for the first time, in which explanation was made in terms of the concept, mechanism, training method and approach of court awareness. From this, it can be seen that court awareness really exists, and plays a significant role which can't be neglected in athletes' reasonable application of skills and tactics.

"Court awareness" refers to the sum of psychological process of athletes to make right judgment and utilization of the object basketball court through vision and thinking. Specifically, it means that athletes can realize what position they are on the ground at any time and anywhere in training or competition, and make responsive reaction according to the condition about attack and defense with their own position into consideration.[1]

2.2 *Formation of court awareness*

Such kind of responsive reaction is a kind of players' reaction based on the object, court through vision, and then imaging is formed on retina, information is conveyed to cerebral cortex through optic nerve passage, and contact is established with motor nerve center through analysis and arrangement, and locomotive organ is governed to make action.[1] Its formation process (e.g. Fig. 1) is that athletes form reactive stimulation towards some

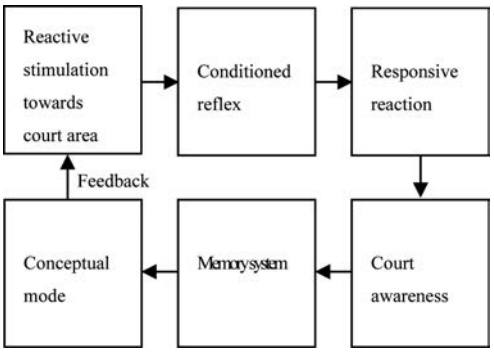

Figure 1. Diagram about the mode of the formation process of court awareness.

court area, establish conditioned reflex, and make responsive reaction, finally a kind of conceptual mode is established and stored in memory system. The revelation of the mechanism and formation process of "court awareness" makes us further know that "court awareness" must be intensified repetitively in training and competition, effective conditioned reflex shall be established, so that our skills and tactical operation more effective and aggressive.

3 TACTICS OF 2/3 COURT ZONE PRESS DEFENSE

The tactics of 2/3 court zone press defense refers to a kind of strongly aggressive and destructive defensive tactics in which all the team members choose 2/3 court area to stand according to certain formation when the situation turns to defense from attack, every team member is responsible for defending certain area, and the attack of the other party is broken through individual active defense and coordination and cooperation of all the team members. Since such kind of tactics features wide moving plane in defense, fierce fight, fast speed, great intensity, and high demand on coordination consciousness, it can bring the strong points of team members into full play and restrict activities of the other party effectively, disturb the deployment and usual practice of the other party, cause mental tension and technical error of the other party, and win over initiative in the competition. It owns four advantages that retreat and defense are fast, formation is concealed; physical strength is saved, fouls are reduced; labor division is specified, blind action is reduced; method is simple, effect is obviously seen and etc. The tactics of 2/3 court zone press defense is a kind of transformation of the full-court zone press defense. Inheriting the core content of full-court zone press defense—midcourt attack and positive steals, it is a kind of basketball defensive tactics with aggressive, destructive and strategic nature and relatively good practical application effect.

4 INTENSIFY COURT AWARENESS, IMPROVE THE EFFECT OF 2/3 COURT ZONE PRESS DEFENSE

4.1 *Improve the understanding about court awareness, specify the guiding significance of court awareness in the tactics of 2/3 court zone press defense*

Although court awareness cannot be seen or touched, it really exists. The correct application of every skill and tactics made by team members in competition is associated with court more or less, and contains the content about court awareness. In time of defense, players also tend to depend on court awareness to make correct judgment towards people, basketball and basket as well as the spatial relations among them, take corresponding and reasonable skills and tactics through timely conceptual work in order to bring their own strong points into full play and defeat opponents more effectively. In 2/3 court zone press defense of such special form, it especially needs to apply court awareness to make reasonable division of court, make full use of court to dominate and guide defense action of athletes. Therefore, we should pay sufficient attention to court awareness, for it has guiding significance towards the tactics of 2/3 court zone press defense.

4.2 *To intensify court awareness can make athletes establish the concept about court and deepen their understanding about tactics*

Basketball awareness can be divided into the perceptual stage, the practical stage and the rational stage.[2] This is also the case with court awareness. Its formation process is started when offensive players enter perception of certain area. Through personal experience of practical exercise and practical application in competition, and then through rational comprehensive analysis, players grasp the basic rules for defense at different distance, different position and in different direction, make application and summary repeatedly in practice, form their own court awareness, and play with high proficiency in competition and fight at limited basketball court.

In the cognitive structure, as the foundation of tactical awareness, court awareness of athletes plays a very important role in correct

understanding of court form, guiding thinking and the implementation of tactical operation, and exerts direct impact on the state of consciousness of subject. On the one hand, the application of tactics made by athletes depends on their ability to make subtle differentiation of court area; on the other hand, it depends on their court awareness formed in the process of teaching training and competition as well as their ability to differentiate the understanding of tactical operation, so that athletes can make proper defense action quickly and accurately in the complicated attack and defense system they have grasped. Athletes with certain court awareness can differentiate zone position at the court easily, and implement proper tactics according to their position. Therefore, to intensify athletes' court awareness can deepen their understanding of tactics.

4.3 *To intensify court awareness can bring the signal reflex action of athletes towards court into full play and improve the integrity of team defense*

The formation of court awareness is a kind of conditioned reflex mechanism, while the condition to form such kind of stimulation is court. Court here is equivalent to signal. Therefore, to intensify court awareness can bring the signal reflex action of athletes towards court into full play. In the whole process of 2/3 court zone press defense, court awareness impels athletes to form conditioned reflex towards the object, court, take reasonable and effective action to change once signal is sent out or according to the condition at the court, and make defense actively and effectively.

4.4 *To intensify court awareness can make athletes make full use of court and take position and labor division in a reasonable way*

The leading point in court awareness is court division and utilization. This is also one problem that must be solved in 2/3 court zone press. Only with good court awareness, can athletes take reasonable position and labor division and get more aware of their own responsibility based on sufficient utilization of court. Take the 2/3 court 1-2-2 zone press defense for example (Fig. 2), Every time when attack comes to an end, all the team members are requested to take their position quickly according to 2/3 court 1-2-2 formation. We can see that different positions are set for different tasks, while different positions can have different defense effect. Therefore, court awareness seems to be especially important as the key to reasonable defense.

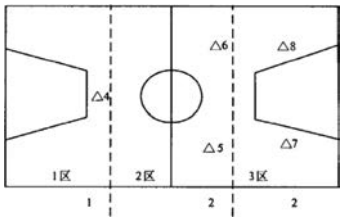

Figure 2. 2/3 court 1-2-2.

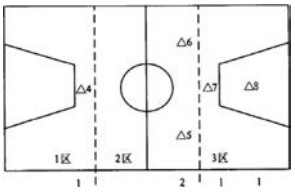

Figure 3. 2/3 court 1-2-1-1.

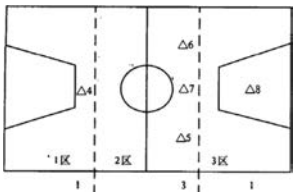

Figure 4. 2/3 court 1-3-1.

4.5 *To intensify court awareness can make athletes change the defense formation of the team properly and improve the defense effect*

In basketball match, the fixed defense formation can't make full use of court. Instead, it is requested to make flexible and variable application according to the characteristics of attack made by the other party, the position of offensive players and actual demand in competition. To intensify court awareness can make athletes have a clear awareness of their position and the position form of the team at the court, change the team defense formation properly mainly according to the position of opponent team members in order to strengthen defense effect. For example, based on the 2/3 court 1-2-2 zone press defense, several kinds of formation transformation as follows can be realized through court awareness of athletes: 1-2-1-1 (Fig. 3); 1-3-1 (Fig. 4); 2-2-1 (Fig. 5), and the defense effect of the 2/3 court zone press is strengthened accordingly. Certainly, the mutual transformation of several formations listed above is guided by defense strategy, so that the offensive intention and the weak link of the offensive party

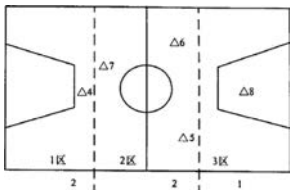

Figure 5. 2/3 court 2-2-1.

can be specified. However, the specific change of the position of team members is still dominated through court awareness.

Through discussion, it is not hard for us to find that the existence of court awareness in basketball awareness is the most fundamental awareness. It is not unfathomable. We should attach importance to the cultivation of court awareness of team members in teaching and training at ordinary times. Court awareness plays an active promoting role in 2/3 court zone press defense. To intensify court awareness can make athletes deepen the understanding of tactics, improve the integrity of defense of the whole team, and enhance defense effect.

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Chinese taekwondo environment analysis and development strategy

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ABSTRACT: In order to popularize taekwondo, enhance the understanding of sport taekwondo and increase participation of the general public, this paper analyses the development environment for Chinese taekwondo by using the literature method, expert interview method, comprehensive logical analysis and SWOT analytical method so as to adapt to the development trend of world taekwondo, increase the number of people teaching and learning taekwondo in China and reveal a strategy for popularizing Chinese taekwondo, thus providing theoretical and practical basis for its further development.

Keywords: taekwondo; environment analysis; development strategy

1 INTRODUCTION

Taekwondo as a traditional Japanese martial art originated in South Korea. As an oriental martial art that differs from western sports, it is of special inherent significance, characteristics and value in the modern world, being a very good popular sport. In the modern world, taekwondo as a popular sport has positive influence on the body and mind of small children, primary school students, middle school students, youngsters, adults and the elderly.[1] It has developed into a great popular sport in the world participated by over 80 million people and 205 member states.[2] China has made substantial achievements in the development of taekwondo, especially in respect of competition. However, due to the insufficient understanding of taekwondo by the people, taekwondo is not developing in a balanced manner with unsatisfactory teaching and learning condition and the instructors are not competent enough, resulting in the low level of popularization of taekwondo in China.[3] Therefore, it has become a matter of first importance for the development of Chinese taekwondo to popularize taekwondo, enhance the understanding of sport taekwondo and increase participation by the general public.

This paper conducts a comprehensive analysis of the development environment for taekwondo in China by using the literature method, expert interview method, comprehensive logical analysis and SWOT analytical method so as to adapt to the development trend of world taekwondo, increase the number of people teaching and learning taekwondo in China, promote popularization projects and reveal a strategy for popularizing taekwondo in China, thus providing theoretical and practical basis for its further development.

2 DEVELOPMENT OF CHINESE TAEKWONDO

China has made relevantly good results in competitive taekwondo despite its short development time. Up to now, athletes of the country have won six Olympic gold medals in individual events (including two gold medals of Taipei, China) and dozens of world (intercontinental) medals in major international competitions such as the Olympic Games, World Championship, World Cup and the Asian Games, showing substantial competitive capacity of our athletes as well as problems such as women athletes performing better than men athletes and insufficient development in the cultivation of reserve young talents and echelon construction. With the taekwondo event entering China in 1992, popular taekwondo stepped onto the stage of history. And with the social development, the sports awareness of the general public has been through constant changes and sports and fitness are more and more valued by the people. Popular taekwondo has hence experienced rapid development in China and taekwondo dojo and clubs of various sizes have opened here and there like bamboo shoots after a spring rain. Based on incomplete statistics, participants in China have presently exceeded 5 million and taekwondo clubs of various sizes over 3000.4 However, generally speaking, the popularization of taekwondo in China is still not well developed and there are a number of problems to be solved.

3 SWOT ANALYSIS OF THE ENVIRONMENT FOR DEVELOPMENT OF CHINESE TAEKWONDO

3.1 *Advantages of Chinese taekwondo in terms of the development environment*

Up to now, the taekwondo event has 202 member states included in the World Taekwondo Federation, becoming the eighth major international sports federation event and being formally accepted as a competition event in the Olympic Games of 2000. Now, it has evolved into a world sport involving huge numbers of participants. And in China, Chinese Taekwondo Association has taken the initiative and set up various management bodies and organizes competitions and events of various forms, forming a management system of a certain kind and attracting huge numbers of taekwondo lovers. In addition, due to the harmonious integration of taekwondo as an oriental Korean martial art with traditional Chinese culture, its rich philosophic thinking, unique spiritual value and exercise value as well as a unified, definite and regulated level management system, taekwondo enjoys remarkable advantages as a good physical exercise in its popularization.

3.2 *Disadvantages of Chinese taekwondo in terms of the development environment*

The deviation of the Chinese government and sports management department, etc. in the understanding of the substantive characteristics of taekwondo has led to its imbalanced development in China and other problems in the popularization of Chinese taekwondo include: low level of the taekwondo association in its scientific and systematic organization and management and inefficiency, small scale, inadequate cultivation of taekwondo talents of various kinds, low level of education, theoretical and scientific studies relating to taekwondo and development of information channels such as various types of modern techniques, publicity media and internet.

3.3 *Opportunities of Chinese taekwondo in terms of the development environment*

At the current stage, the sports policy of China has placed its emphasis on popular sports and national fitness and the country and government pay much attention to the people's livelihood and the health of the body and soul. With the rapid social and economic development of China, the people have more and more realized that they should achieve mental health through leisure sports, rich spare-time life and social welfare development. Shift of the people in the modern world to healthy mental and physical entertainment and emphasis has promoted the change in their understanding of the value of the most representative Japanese sport and the fitness effect of life sports, which provides a great environment opportunity for the popularization of taekwondo in china.

3.4 *Threats of Chinese taekwondo in terms of the development environment*

Presently China still has its emphasis placed on the pursuit of gold medals due to the national sports system which values competitive sports and neglects rational thinking on popular taekwondo resulting in insufficient understanding of the nature, connotation and value of taekwondo, especially in respect of the popularization of sport taekwondo. In addition, the imbalanced development of regions, culture and economy, development difference between various regions, provinces and cities, difference in local customs and practices between nationalities and regions as China is a country with a large population and a number of nationalities, especially the fiercely competition for market share proportion among various national sports, civilian sports and folk sports, have become a thread for further popularization of taekwondo in China.

4 STRATEGY FOR THE POPULARIZATION OF CHINESE TAEKWONDO

Based on analysis of the environment for the development of Chinese taekwondo using the SWOT method, the following strategic guidelines for popularization of Chinese taekwondo is proposed: according to national policies and trend of social economy and people's demand, give play to the nature characteristics and advantages of the taekwondo event, strengthen organizational management standard, enhance the understanding of taekwondo of various groups of people, conduct propaganda and promotion activities of various forms, carry out promotion of taekwondo extensively to give an impetus to further popularization of taekwondo. Specific strategies include.

4.1 *The country and government should further transform thoughts and emphasize the popularization of taekwondo*

The country, government and management authorities should further change their understanding of the taekwondo event, realizing that the focus for the development of taekwondo is not on the development of competitive sports but on popular sports

and that development of popular taekwondo will drive the development of competitive taekwondo. Taekwondo will have a development basis only when the taekwondo event is effectively carried out and popularized in popular sports, thus meeting the demand of people in the modern world for healthy life sports while promoting the standard of competitive taekwondo. More manpower, materials and financial resources should be invested in taekwondo so that various tasks can be implemented more effectively to promote the sound development of taekwondo.

4.2 *Strengthening and improvement of functions of organization and management bodies such as Chinese Taekwondo Association*

The Chinese Taekwondo Association should take the lead to strengthen the construction and management of various local associations, special societies, dojo, clubs and organizations. Relevant bodies shall be established at various provinces, cities and regions to manage and promote taekwondo. And relevant associations and organizations should be established in various industries and units in various forms so as to form a systematic organizational network to promote taekwondo in the country. Duties of departments at various levels and management systems should be improved to regularize the approval, setup, standards of associations and dojo at various levels, form various levels of systems related to trainers, instructors and referees, enhance the quality of personnel involved in the industry to form a good development order for organizations such as associations and dojo and to regularize and promote the taekwondo competition system to organize amateur and popular taekwondo competitions of various kinds.

4.3 *Intensifying the cultivation of taekwondo talents*

Supported mainly by government investment, cultivation of relevant special talents should be strengthened including trainers, referees, instructors and social sport instructors. Trainers and instructors should be further trained regarding theoretical knowledge such as taekwondo connotation and value awareness so as to enhance their understanding of the nature of the taekwondo event and master taekwondo knowledge in a better manner, providing a correct and scientific theoretical basis for the application of more effective teaching and training methods. The taekwondo subject and research institutes should be established at national institutions of higher learning with relevant public, specialized and selective courses and subjects related to taekwondo established to cultivate special taekwondo talents and guarantee the supply of human resources for the popularization of taekwondo.

4.4 *Strengthening the development of theories and scientific research related to taekwondo*

The Chinese Taekwondo Association should take the lead to establish special organizations and departments for theoretical research of taekwondo; sort out theories related to the nature, significance and value of taekwondo in a scientific manner; organize training classes for referees, trainers and instructors in a regular and irregular manner to improve their theoretical level with regard to taekwondo; carry out theoretical sorting and scientific research regarding the value of taekwondo as a modern life sport to find a way suitable to the characteristics of Chinese people and the development environment of China; establish special organizations related to taekwondo such as relevant academic societies and establish theory communication platforms such as society logs, various periodicals and magazines; stimulate the initiative of special personnel involved in the taekwondo event and taekwondo lovers in taekwondo theoretical research.

4.5 *Intensifying publicity to increase the number of people teaching and learning taekwondo*

Publicity should be intensified through media, newspapers, magazines and the internet to make more people know about taekwondo, understand taekwondo and promote taekwondo so that the audiences of the taekwondo event as a good modern life sport can be increased to enable people to experience the value of the martial art in routine life. Teaching should be made for taekwondo trainers, learners and taekwondo lovers in respect of techniques, body and soul, thoughts, etc. with teaching contents covering theories, basic movements, leg techniques, patterns, pair work, demonstration and defense techniques. The teaching plan should increase the proportion of taekwondo spirit. Education and publicity should be made to strengthen the correct understanding of taekwondo so as to provide theoretical development conditions and environment to increase taekwondo participants and enhance competitive level.

4.6 *Further popularizing and promoting taekwondo effectively*

Various levels of social dojo should promote the special quality of the managerial staff and instructors while perfecting facilities and education plans, updating education contents, improving education

methods to form education plans suitable for different groups of people and should attract more participants through advanced conditions, effective education plans and positive publicity methods. Popularization efforts should be intensified in groups such as enterprises and major communities to strengthen their understanding of the taekwondo connotation and value, attracting more people to take part in the taekwondo event. In addition, taekwondo should be promoted and popularized as a life sport in primary and middle schools and colleges and universities. Special cultivation of taekwondo teachers and trainers should be intensified to enable them to teach correct taekwondo knowledge. Taekwondo teaching and evaluation system should be improved and taekwondo should be properly applied to various kinds of entrance exams and physical education specialty exams so as to promote it as a school sport.

5 CONCLUSION

During the fast development of Chinese taekwondo in a short time, competitive taekwondo has made remarkable achievements but life sport taekwondo has encountered a number of problems in its popularization such as insufficient understanding of taekwondo, poor promotion result and imbalanced development. Taekwondo as an important part of the Korean fad is being developed in combination with traditional Chinese culture and people are gradually accepting the value, thought, spirit and essence of taekwondo. In China, taekwondo as a life sport has huge potential for development and there are a number of issues that require follow-up attention and research such as how to make taekwondo more popular with the people and acquire more audience markets and how to optimize and boost the essence of taekwondo to make it a sport with Chinese characteristics.

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Key technology research of personalized virtual learning community

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ABSTRACT: The construction of the key technologies of personalized virtual learning community is the use of virtual reality technology to build an immersive virtual learning platform situational digital; utilize portal technology to customize individual learning portals; utilize web crawler digging integrate online learning resources, and ultimately learn by personalized self-learning.

Keywords: personalized learning; virtual learning communities; web crawler; portal technology

1 INTRODUCTION

National long-term Education Reform and Development Plan (2010–2020) states: vigorously develop modern distance education, and other building to satellite television and the Internet as the carrier continues to open and distance education and public service platform to provide convenience for the learner, flexible personalized learning conditions to meet the individual needs of a variety of learning and development. Personalized virtual learning community for its autonomy, individuality, without the constraints of time and other characteristics, to provide learners with an easy-to-use, personalized learning platform to meet the learners' personalized learning, independent learning, immersive learning situations demand, thus greatly improving the learning efficiency of learners, promote the development of modern distance education.[1]

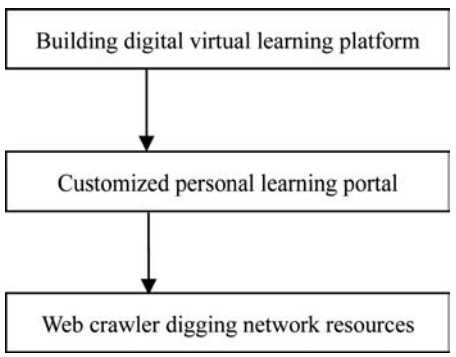

Figure 1. Build personalized virtual learning communities Technology Roadmap.

2 TECHNOLOGY ROADMAP OF PERSONALIZED VIRTUAL LEARNING COMMUNITY

First, the use of virtual reality technology to build an immersive virtual learning contexts digital platform, and then use the portal technology to customize individual learning portals, web crawler digging. Finally, the integration of online teaching resources needed to achieve personalized learning self-learning. Build personalized virtual learning community technology roadmap shown in Figure 1.

3 KEY TECHNOLOGY OF PERSONALIZED VIRTUAL LEARNING COMMUNITY

3.1 *The use of virtual reality technology to build immersive virtual learning contexts digital platforms*

In order to increase interest in learning and immersion learners, introducing network game developers to construct the diversity of situations, role playing, realistic and teamwork and other ideas, integrated use of Web 2.0, Web3D and Web GIS technology, based on virtual reality technology to build immersive virtual learning contexts digital platforms. Learners in immersive virtual learning contexts digital platforms, not only can learn individually, you can also team up to play relevant roles by way of immersive, be independent, personalized, diversified and efficient learning. The digital virtual learning platform of "learner-centered as the main body, for all learners service" construct. Learners use the digital virtual learning platform, combined with their own situation, the use of virtual reality technology

with interactive, immersive, simulation and other features, according to their own interests and hobbies, learning content discretion, change from passive learning to active learning; improve teamwork capacity, improve emotional loss and loneliness caused by separation because of time and space. Immersive virtual learning platform situational figures provide learners with a smooth interactive platform, creating a personalized learning, personalized learning environment, greatly mobilized the learner initiative, enthusiasm, greatly improving the learning efficiency and quality.

3.2 *Use of portal technology, customized personal learning portal to meet the individual needs of diverse learners*

Portal technology for different user content aggregation, customizable user interface, personalized learning. Learners through a unified identity authentication login after a virtual learning community, learning content can be selected according to their needs and customize learning and progress, change only accept the monotony of learning content in the passive situation, improve the autonomy and motivation to learn. Personalized information platform virtual learning community, through the Path of learners can determine learner preferences and formulate recommended learning path to help learners to content aggregation based on study habits, differences in the level of knowledge and different learning styles, and create their own user interface, accurate positioning of content of interest to learn learner, self-determined learning progress and improve the service levels of personalized learning.[2]

The use of virtual learning community portal technology has the following advantages:

1. Autonomy

Autonomy refers to learners from passive learning to active learning. Learners according to their interests, learning styles and even learning objective is to actively select learning content, learning partners, teachers, teaching resources, learning, evaluation methods. Personalized Virtual Learning Community support learners according to their own ideas ideas custom assembled personal portal to add learning resources they need, the team members to their community portal being, and can be adjusted at any time on demand, dynamically updated.[3]

2. Personalized

Personalization is reflected in their learning characteristics of learners. Registered members after learners can enter into a customized and personalized learning portal, select the desired combination of their actual curriculum, customized relevant learning resources to achieve one's individualized education. Personalized include: learning time and place of personalized; learning content and schedule personalized; learning personalized and individualized learning assessment methods. Personalized virtual learning, the learner is the real owner of the personal learning portal, it can be self-management, you can get a great sense of belonging and identity, improve the learning initiative and enthusiasm.

3. Accuracy

Because learning resources are customized according to user needs, precise practicality resources has been a reliable guarantee to improve the learning efficiency. As the master learners learning path, the portal can be based on the interests of learners hobbies, learning resources, learners can push the required precision to ensure the dynamic update of resources.

3.3 *The use of customized web crawler digging optimize network resources for education*

Online education resource library is a necessary foundation for learners online learning, otherwise it would become "bricks without straw", so to develop a content-rich, convenient and practical and safe use of online education resource library;[4] We must also realize, again abundant local resources, it is also limited, so be sure to take advantage of the rich network resources, such as: Baidu Encyclopedia, Wikipedia, professional forums, national excellent course websites. However, it is precisely because of too rich network resources, learners but feel no choice, dazed confusion, which is on the need for massive screening network resources, integration, optimization and customized to achieve the target learners use. Then we must develop a customized Web crawler to digging, optimization, integration and customization of network resources. Web crawler design principles are as follows:

1. Basic concept

Web crawler is an automated program to collect information on the Internet. Not only for the search engine crawlers collect network information through the network, and can be used as directional information collection, directional collect specific information about some website. The system is mainly collected Baidu Encyclopedia, Wikipedia, professional forums, websites and other related national fine lesson about computer technology.

2. Works

Select seed URL to be crawled into the URL queue, and then get the host for DNS resolution IP, based on the URL to download the corresponding page and in the database, the last of these URL into the URL queue crawled its storage.

3. Customization
Customized web crawler is to make good rule in accordance with pre-customized strategies purposefully active grab the necessary resources. Specific, you can use qualified domain name, IP strategy and defining the rules defining keywords and other forms. The system of domain names and IP will be mainly limited to the Baidu Encyclopedia, Wikipedia, professional forums, such as the National Quality Course Web sites, mainly limited to the words "computer" aspect.
4. Information storage
After digging a custom resource web crawler digging cleaning convert stored in the local database for learners.

4 CONCLUSION

The personalized virtual learning communities can be used as a public service platform of modern distance education, the project successfully resolved at this stage due to the use of distance education in the backward mode of teaching can not effectively exist, such as personalized learning, independent learning a lot of problems to be solved issues through the implementation of the project, can greatly improve the efficiency and quality of distance education level, can bring significant economic and social benefits, thus promoting sustainability leapfrog development of modern distance education, while the construction of universal learning, lifelong learning learning society also has some positive significance.

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Development of standard connector library system based on UG software

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ABSTRACT: The standard connector library system has vital significance to the fast manufacturing of e-machine equipment model. This paper aims at the problems of standard connector model which is vital to routing. First the characteristics of connector library and the current methods are analyzed. Then some key technologies of establishing standard connector library are studied. Finally based on UG secondary development and interface technology, parametric 3D connectors' library was developed. This standard connector library has improved the design efficiency greatly by application.

Keywords: secondary development; connectors library; 3D modeling; interface technology

1 INTRODUCTION

E-machine communications, as the main products, are now widely used in various communications. With the rapid development of science and technology, both in the field of civil and military field, the demand of electronic machine are increasingly growing. Computer aided design technology can be used to quickly and accurately complete the three-dimensional design of digital electronic machine.[1] While large quantity connectors with shape complexity are used in electronic machine, so a standard connector library of three-dimensional model should be created to reduce the machine design time, which is a great significance for the design, manufacture and assembly.

This paper studied the integration of Visual C + +6.0 development environment, by the UG secondary development to establish standard connector library. Firstly the technology of UG interface combined with the MFC and parametric modeling technology is discussed. Then based on ADO (Active Date Object) and UG/OPEN API technology a parameterized three-dimensional library is established. The method is a highly reusable code that can effectively improve the design efficiency of connector modeling and routing.

2 MODELING METHOD OF STANDARD CONNECTOR LIBRARY

The standard connector modeling has vital significance to the fast manufacturing of three-dimensional electronic machine. There are two main methods of modelling:[2] One is the static model, namely the approach of library establishment is to establish solid CAD model respectively, then a fully three-dimensional model of the standard connector is obtained which contains a number of threeding a database workload, share a large space, and it is not parameterized in the form, not carrying the ways by changing the parameters to change the three-dimensional model of standard parts. Therefore, it is difficult to maintain and extend the standard library; another is the dynamic programming model, that is, parametric feature-based three-dimensional modeling approach. By this way, all standard parts library of standard parts has its own characteristics and parameter control. This method has strong point of small space consume, easy to add or delete and modify. The key technology of this method is the standard connector parameters feature analysis and database access.

UG software commonly used in building a database of standard parts library methods, such as expression method, User Defined Features (UDF) method, spreadsheet method and programming

method. All these methods have the feature of the establishment of a three-dimensional model of standard parts manually or procedurally, and then using different methods to modify the parameters to meet the requirements. The expression method has the characteristic of easily creating and conveniently modifying, but users need to find standard parts manually to modify the parameters, which are inefficient and complex. The user-defined feature method, which can create links between features, is easier to define feature of the variable. It can set the default values, prompt for a key value, restore and edit the value easily. Each call requires a new part to enter the user defined features, with the feature of low degree of automation. Spreadsheet method provides a three-dimensional physical format defined by UG standard parts library system, which is created an intuitive easily, and transferred through an intuitive graphical interface assembly. Standard parts have a sub-assembly capability, and can be encapsulated in UG software, and that is the general method of establishing standard parts library. However, it need to detailed classification of parts. Management and using of this library are cumbersome and not intuitive. Higher level of secondary development application is applied to establish a standard parts library with easy, simple, user interface, but it has the feature of programming workload, complexity of implementation technology.

In this paper, the way of data-driven template part is used to generate a new three-dimensional model of the standard connector. Firstly the connector template part has been established, which include the standard connector geometry and non-geometric information, and is stored in the parameter database. Then the standard connectors library was designed combined the Visual C + +6.0 MFC with the user interface of UG/OPEN API. Generally, the user can get standard connector modeling directly by using the driver parameters on UG platform.

3 KEY TECHNOLOGIES OF DEVELOPMENT

3.1 *Interface technology*

Three kinds of engineering application wizard provided in the Visual C + + 6.0 environment, Only the DLL file generated by UG/Open AppWizard can be directly called by UG.[3] However, UG/Open AppWizard does not support MFC, which can not directly call the MFC application to achieve communication with the MFC. Especially, the database can not connect with the MFC application. Therefore, we must resolve the interface problems. Figure 1 showed the interface realization

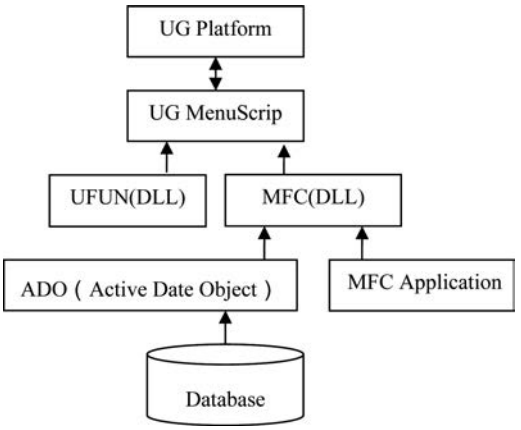

Figure 1. Interface realization technology.

technology on the UG platform by Secondary development toolkit.

UG/Open AppWizard can not only be as Dynamic-Link Library (DLL) to achieve UG graphical interface within the system and internal communication, but also through the Dynamic Link Library (DLL) implementation of the way fast, a way through the embedded DLL to achieve communication between UG and the MFC are proposed. Figure 1 shows the interface program.[4] The first step is to create an MFC AppWizard (DLL) project, then set the engineering environment, and join the UG/Open API entry function. So the aim of communication database would be achieved, and the program could be generated by MFC.

3.2 *Development of standard connector library*

The main features of the connector library are: 1) Connector types have many kinds which could be divided into round, rectangular and special types. The same type of connector has similar shapes, but the number of ports is different, all we need is to change the parameters to generate the model. 2) Connector model serves mainly as a whole wiring assistance, which could simplify the independent of the characteristics, and the related need for accurate feature set, such as port properties location and multi-port properties. 3) Connector is usually used in pairs with the mother and child piece parts, the two are connected by tight fit, some features are related.

Application of relational expression method, user defined features methods and spreadsheet method would be difficult to complete the connector library building, while it can be achieved by programming method. Development process is as follows: First, classifying the connectors by

their shape features. Then, according to the special shape of model and needs for wiring, simplifying the models. The simplified model is decomposed into a primary and secondary characteristic and to extract the small size of the main parameters determine the model. UG secondary development language development using three-dimensional model to establish procedures for all of its features to be used for parametric modeling and can be changed according to the number of multi-port port location. Finally, the MFC was developed to interface the same time. According to standard parts of the main parameters, the main parameters of standard parts should be found out, and transfer interface between the main parameter database and application would be established. Finally, system menu and dialog boxes were created. Figure 2 shows the system menu of tools for developers to achieve seamless MFC connection with UG software.

3.3 *Database access*

By using feature modeling technology and topology constraints, three-dimensional parametric standard connector library was established. The goal of database design is to provide a highly efficient operating environment for the users' applications for. Database system and its interface formed the parameter library that enables the connector to store and access main parameters, and assign the appropriate connector model parameters. Connector model structure is complicated and has many feature parameters. Therefore, the main parameters of models should be determined; this method can effectively reduce the connector model parameters.

Standard connectors used entity relationship model is ER model. It is established, managed and maintained by Visual C + +6.0 development tools and MFC functions, and ADO access databases. Figure 3 shows the connector parameter database management systems interface. First obtain permission to connect to the connector parameter library to access and modify the main parameters, then other parameters corresponding will change with the main parameters. The connector modeling was updated accordingly with the parameters.

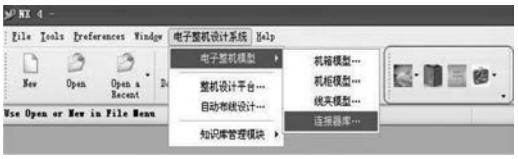

Figure 2. Interface system menu of tools for developers.

Figure 3. Database management interface.

4 SOFTWARE IMPLEMENTATION

Standard connector model include interface, database, and a variety of qualify part. Interface can be used to human-computer interact, database store a simplified model of the main features of the connector parameters, through a variety of database access interface, standard parts required for the current parameter value can output to the dialog box interface. Parameters in the dialog box that is assigned one by one the corresponding model generation program Variable. It can also be modified in the database information.

Figure 4 shows the standard connector main user interface library. The left side of the connector interface is the type of tree navigation. According to the characteristics of shape, connector type can be divided into rectangular connectors, circular connectors and special connectors. While the standard connector model is created, through the left navigation tree a standard connector will be selected, the right window will also show the standard connector type and the geometric parameters of the main information. By choosing the required connector, the system can display all the main parameters of the connector information automatically. All the main parameters of the connector information are stored in the database, and the remaining parameters are associated with the main parameters. According to the main parameter information the appropriate template file type connector can be called to generate connector model.

Figure 5 shows the connector model. Qualify part allows users to add routing specific intelligence to a part file. This intelligence dictates how the part is placed into a routing assembly, how it relates to other part in the routing assembly, and how it behaves during routing operations. In addition, it manages the electrical connectivity information as well as mechanical connectiv-

Figure 4. Connector library application program interface.

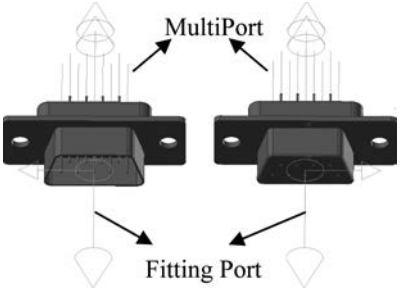

Figure 5. Qualify connectors.

ity information. Qualify connector provides the exclusive interface for creating routing specific objects in a part file that carry this intelligence. Port property generally includes multiport and fitting ports. Fitting ports are used for connecting devices and connectors. Multiport are used for port to port mating, if lock engagement is selected. Multiport are created to multiple logical connections using a single connection object. The multiport represents a collection of logical connections by maintaining a list of unique identifiers. So the process in the wiring system can accurately locate a specific multiport.

5 SUMMARY

Based on the interface technology of UG secondary development and the characteristics of the standard connector model, combined UG/Open API interface with the secondary development and MFC Application Wizard, realized the UG interface entry function problem, this paper achieve the secondary development of database applications with UG (MFC DLL development program) Integrated.

The standard connection established library system has intuitive interface, easy operation, functional. Users can easily and quickly generate the required connector model, greatly reducing the routing time before create the e-machine model, which is effectively improving the efficiency of electronic machine layout design.

ACKNOWLEDGMENTS

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Computer, Intelligent Computing and Education Technology – Liu, Sung & Yao (Eds)

A further study on semantics demonstrativeness' control on the transformation from "NPL + have (you) + Num-Classifier-Noun phrases" sentence pattern to "on (zai)" sentence pattern

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ABSTRACT: Because of the transformation of the situation of referential expression, the indefinite numeral "one (yi)" in "NPL + have (you) + ncp-np" sentence pattern should be shifted into definite article "the(na)" in "on (zai)" sentence pattern. Therefore, the strength and weakness of semantics demonstrativeness controls the transformation from "NPL + have (you) + Num-Classifier-Noun Phrases" sentence pattern to "on (zai)" sentence pattern.

Keywords: semantics; demonstrativeness; accessibility; NLP

1 INTRODUCTION

In recent years, some scholars have already noticed the significance of lexical-semantics in the study of grammar. Lu (2004) proposed that sentences or even the whole passage, to some extent, can be regarded as a conceptual network. First of all, people should pay attention to the analysis and understanding of the meaning of each word in the sentence if they want to analyze or understand a sentence or a whole passage. At the same time, Zhao (2008) proposed that semantics is the basis of syntax. Semantic meaning set the syntax pattern. The meaning of the words set the frame of semantic meaning expression (that means how many semantic roles comprised and what kind of semantic role can be matched). The frame of semantic meaning expression set its basic syntax pattern (that means some basic syntactic component co-occurrence, the basic organized model of syntactic component). According to the two viewpoints above, semantic meaning has the decisive effect on the understanding of the meaning of sentence and grammar. These two scholars have stated the effect of semantic meaning towards the grammar; this thesis will discuss on semantic demonstrativeness' control on the transformation from "NPL + have (you) +Num-Classifier-Noun Phrases" Sentence Pattern to "on (zai)" Sentence Pattern.

2 DEMONSTRATIVENESS AND ACCESSIBILITY

Referential expressions have a certain form and semantic feature, which have the syntax function.

The basic presupposition of the identification Principle is the corresponding relationship between accessibility and the language expression. For example, in the discourse, the shorter form reflects the higher accessibility ability (such as zero forms, pronouns, etc.). On the contrary, it has lower accessibility ability (such as noun, etc), the longer language form reflects a lower accessibility ability (Xu 2004). Chafe (1987) holds that people's memory states are the main cause to decide the distribution of referential expressions in the discourse. The basic assumption is that there is a certain corresponding relationship between memory state and language form. He divided the activation which showed human beings' mind state into three types: active, semi-active and inactive. Activation is the important factor of markup language expression; it decides the distribution of referential expression in the discourse. In Chafe's model, the activation has two different dimensions: the activation and the length of time. The longer the time, the lower the activation is. On the contrary, the activation will be higher.

Ariel has established the accessibility theory to explain the distribution of referential expressions. The basic understanding of the theory is that the selection of referential expressions and the accessibility of referential object in the memory have a corresponding relationship. Language expressions carry different degrees of accessibility. The degree of accessibility of referential expressions is decided by four factors: distance; the competition of referential expressions; salient and consistent. According to accessibility, Ariel (1988) categorized referential expressions and he thought that

the choice of referential expressions relied on accessibility. The basic assumption on this theory was the amount of referential expression can carry demonstrativeness was the main cause of the choice of referential expressions. Shen Jiaxuan came up with the concept of lexical-semantics demonstrativeness and accessibility. Demonstrativeness means the speakers' referential expressions indicate the listeners searching information from their mind or surroundings to find the target object or the complexity of the events (Shen 2011). If the events have high demonstrativeness, they have got high referential degree and if the events have low demonstrativeness, they have got low referential degree. Accessibility means speakers suppose that after listeners hear a referential expression, they will search information from their mind or surroundings to find the target object or the complexity of the events. The referents which can be found easily have high accessibility, and which are difficult to be found have low accessibility. According to the views of Shen, if the lexical-semantics have high demonstrativeness, the target object has got low accessibility and vise verse.

3 USING THE THEORY OF THE STRENGTH AND WEAKNESS OF SEMANTICS DEMONSTRATIVENESS TO EXPLAIN THE TRANSFORMATION FROM "NPL + HAVE (YOU) + NCP-NP" SENTENCE PATTERN TO "ON (ZAI)" SENTENCE PATTERN

"Have" (you) sentence is one of the special sentence patterns in modern Chinese. This kind of construction is a typical existential sentence in Chinese which is frequently used. "Have" (you) sentence are listed in the low level grammar in the universally used Chinese textbook. However, the error rates are still very high in the actual learning. According to the statistics from *Beijing Language and Culture University HSK composition corpus*, the accuracy is low in Chinese grammar, and the error rate for the South Korean students is particularly high. Because there is no difference between the meaning of "have" (you) and "in" (zai). The students are affected by negative transfer of their mother tongue and the grammar generalization of the target language. For example,

1. 교사의? Is the teacher in here?
2. 교사는 어떻게? Is there a teacher here?

Both of the two sentences mean: "is the teacher here or not". The example (2) "Is there a teacher here" is a kind of existential construction, but it doesn't make any sense in Chinese because "have" (you) here is a subordinative meaning but not the existential meaning. However, there is no difference between "have" and "in" in Korean, both of the two expressions can be used. Therefore, when learned Chinese as a foreign language, South Korean students often make mistakes between the use of "have" and "in". For example:

3. There is a bottle of water on the table.
4. There is a basin on the ground.
5. *That bottle of water is on the table.
6. *That basin is on the ground.
7. That bottle of water is on the table.
8. That basin is on the ground.
9. *A bottle of water is on the table.
10. *A basin is on the ground.

The sentences with the symbol* are not often used in Chinese, we can explain that sentence (3), (4) and (7) and (8) are right through the old and new theory: generally speaking, the new information appears in the end and the known information appears at the beginning of the sentence. That sentence (5), (6) and (9), (10) are not right is because that the known information will not appear at the end of the sentence and the new information will not appear at the beginning of the sentence. The numeral word of "a" in the sentence "A bottle of water" is uncertain, it's the new information. However, the demonstrative pronoun of "that" in the sentence "that bottle of water" is certain, it's the old information.

Generally speaking, the new information and the old information are different from people to people. Students didn't pay much attention to it and they can't grasp the difference between them. Under such kind of circumstances, how should we explain it? Shen Jiaxuan's theory of lexical-semantics demonstrativeness can explain it. Generally speaking, whether the demonstrativeness is high or low is decided by the objective state of referential expressions. For example, the demonstrativeness in a sentence with an indicator is higher than the sentence without an indicator, the demonstrativeness of personal pronoun is higher than the demonstrativeness of general nouns. Sentences with more determiners have higher demonstrativeness than sentences without many determiners. The stressed sentences have higher demonstrativeness than non-stressed sentences.

So what's the function of "there" (na)? It is to improve the demonstrativeness of the referential expression, that is to say, to improve the accessibility of the referent. The referents which can be found easily have high accessibility, and which are difficult to be found have low accessibility.

In example (3) "bottle of water" and in example (4) "a basin" both have low demonstrativeness. According to the assumption of the speaker,

after the listener heard the referents of "a bottle of water" and "basin", they searched information in their memory or the surroundings; if the listener is not difficult to find the target object "water" and "basin" which are given the definite characteristics, the strength of the speaker's referential expression's demonstrativeness is low. So in example (3) and (4), to the speaker, It is obvious for the listener that "a bottle of water" and "a basin" have high accessibility, that's why he uses low demonstrativeness "a bottle of water" and "a basin".

Shi (2004) thought that typical quantitative phrases have no fixed semantic characteristics and they should not be put at the beginning of the sentences at will. Go in seriously, it is that quantitative phrases have low demonstrativeness. So example (9) and (10) can also be explained by semantic demonstrativeness and accessibility: to the speaker, "a bottle of water" and "a basin" are explicit, unfixed, with low accessibility, so he uses low demonstrativeness "a bottle of water" and "a basin", but these expressions make people confused and can't appear at the beginning of a sentence at will, it is also hardly use in our oral expressions.

However, In example (7) and (8), "that bottle of water" and "that basin", according to the assumption of the speaker, after the listener heard the referential expressions, they searched from their memories and surroundings, it is hard to find the target object "water" and "basin", so they add fixed words "that" to make them fixed and have high demonstrativeness. Therefore, in example (7) and (8), the speaker thought that objects are implicit to the listener and have low accessibility, so he uses high accessibility referential "that"; but in example (5) and (6), to the speaker, the objects are explicit and have high accessibility, so they should not be "that bottle of water" or "that basin". Such kinds of sentences are rare in Chinese.

4 IN SPECIAL CONTEXT, THE STRENGTH AND WEAKNESS OF SEMANTICS DEMONSTRATIVENESS TO EXPLAIN THE TRANSFORMATION FROM "NPL + HAVE (YOU) + NCP-NP" SENTENCE PATTERN TO "ON (ZAI)" SENTENCE PATTERN

If we add particular context to example (5), (6), (7), (8), it seems that they can still be understood, for example:

5. *That bottle is on the table. → I drank this bottle of water, that bottle of water is on the table.
6. *That basin is on the ground. → I used this basin, that basin is on the ground.
9. *A bottle of water is on the table. → A bottle of water was on the ground; a bottle of water is on the table.
10. *A basin is on the ground. → A basin is on the frame, a basin is on the ground.

How to explain this kind of phenomenon? In example (11) and (12), to the speaker, he thought that "that bottle of water" and "that basin" are implicit to the listener, they have low accessibility, so he added particular context, " I drank this bottle of water" and "I used this basin". "this" and "that" appeared together to improve the accessibility of "that bottle of water" and "that basin", so it is appropriate to use "that bottle of water" and "that basin" in this context. In example (13) and (14), to the speaker, "a bottle of water" and "a basin" are implicit to the listener and have low accessibility, so he added particular context and use comparison "a bottle of water is on the ground" and "a basin is on the frame" to make "a bottle of water" and "a basin" have high accessibility, so example (13) and (14) are appropriate in this context.

15. That tobacco pouch is on the table. Conan Doyle, *the return of Sherlock Holmes*, Black Peter
16. However, they in here, one was dead and the other has been abroad. Liu Zhanqiu, *A Fashion for the Men of Letters to Auct the Privacy, Different Views on the Phenomenon of LIU Zhanqiu, by Zhao Guoming*.

Example (15) and (16) are found in CCL corpus in Beijing University, example (15) is the only sentence which match "NPL + have (you) + nip-up" sentence pattern. This sentence pattern appeared in the conversation between Holmes and Hopkins. "Tobacco pouch" has low accessibility and demonstrativeness, so the author used referential expression "that (na)" to improve the demonstrativeness of the referential object, so "that Tobacco pouch" became the common knowledge of the two persons. To the speaker Hopkins, "that Tobacco pouch" had high demonstrativeness, that's because to the listener Holmes "tobacco pouch" had low accessibility; therefore, demonstrative pronoun "that (na)" was appropriate to be used here. Example (16) has similar sentence pattern to example (13), just example (16) omitted noun "person (ren)"; "one (yi)" here meant one of "them (ta men)", so the accessibility can be relatively high, in this sentence, two "one (yi)" were also appropriate to be used here. If we use new-old information theory to explain example (15) and (16), it is contradictory. It seemed that we can use lexical-semantic theory to explain the phenomenon.

Shen (2011) said that distinguishing accessibility and demonstrativeness is to differentiate the speaker and listener: accessibility relates to

the listener and demonstrativeness relates to the speaker; accessibility is in terms of alleged target and demonstrativeness is in terms of referential expression. This also pointed out on the other way there is little grammar when it is separated from semantics and pragmatics.

5 CONCLUSION

Referential expression "that (na)" is just like a hand to improve demonstrativeness, so the referential lexical meaning of "that(na)" improve the lexical demonstrativeness. In the process of NPL + have (you) + nip-up sentences transform to "on (zai)" sentences, for the place of the referential expression changes, so the indefinite quantifier "one (yi)" has to change to "that (na)" and the sentence change into "na +quantifier +noun+on + NPL" pattern, it can finally transformed successfully. In special context, referential things are the common knowledge of both speaker and listener, which have high demonstrativeness, we can also use "NPL + have (you) +Num-Classifier-Noun Phrases" Sentence Pattern; though the things are not specific references but only referred together and has high accessibility, we also use "Yi+ quantifier + on + NPL" sentence pattern.

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Sensitivity analysis on transient responses of coupled transmission lines in the time domain

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ABSTRACT: A new method based on the precise integration is presented in this paper, which is used to analyze the sensitivity of the transient responses of the coupled transmission lines. In this method, the telegrapher's equations of coupled transmission lines in the time domain are firstly differenced and discretized in spatial domain, and then the first-order differential equations of the sensitivity of transient responses of the transmission lines with respect to time are established. By this method, the sensitivity analysis on the transient responses of the coupled transmission lines is transformed into solving the transient responses of transmission lines and the first-order differential equations. This method can be applied to analyze the uniform and non-uniform transmission lines and the arbitrary loads. Example given shows the validity and consistency of the suggested method.

Keywords: coupled transmission lines; sensitivity analysis; transient responses

1 INTRODUCTION

With the rapid increase of the signal frequency and the decrease of the size, the analysis and design of the interconnections become more important in the high-speed Very Large Scale Integration (VLSI) chip and the printed circuit boards. Improper design could result in signal delay, reflection, crosstalk and false switching,[1] etc., seriously the circuit cannot work. Therefore, the transmission line effects have become a bottleneck in the development of high-speed VLSI and it is necessary to find the key factors that influence transmission line effects and provide the basis for the design of VLSI.

The sensitivity analysis on transient responses of transmission lines has two methods, the time-domain method and the frequency-domain method. The frequency-domain method include the numerical inversion of Laplace transform[1–3] and the adjoint network,[4,5] etc, which is often used but complex to compute and difficult to analyze the nonlinear load problem. The time-domain method is of simplicity, but the stability and precision of the algorithm is hard to guarantee because of the effects of the time step and space step.

In this paper, the method based on precise integration of sensitivity analysis on transient responses of the coupled transmission lines in the time-domain is presented, in which the telegrapher's equations of the coupled transmission lines in time domain is differenced and discretized in spatial domain, then the first-order constant coefficient differential equations about the sensitivity of the transmission lines transient responses with respect to time is established. Through this method, the sensitivity analysis on transient responses of the coupled transmission lines is transformed into solving the first-order differential equations and the transient responses of transmission lines. This method is stable and simple, can analyze any types of uniform and non-uniform transmission lines and loads. The examples as given below illustrate the reliability and validity of the method presented in this paper.

2 SENSITIVITY OF THE TRANSIENT RESPONSES OF COUPLED TRANSMISSION LINES

Under the TEM wave approximation, the voltage and current of multi-conductor transmission lines satisfy the telegrapher's equations.

$$
\begin{aligned}
-\frac{\partial \mathbf{v}(x,t)}{\partial x} &= \mathbf{R}\mathbf{i}(x,t) + \mathbf{L}\frac{\partial \mathbf{i}(x,t)}{\partial t} \\
-\frac{\partial \mathbf{i}(x,t)}{\partial x} &= \mathbf{G}\mathbf{v}(x,t) + \mathbf{C}\frac{\partial \mathbf{v}(x,t)}{\partial t}
\end{aligned}
\qquad 0 \le x \le 1 \tag{1}
$$

where l is the length of the transmission lines, and

$$
\mathbf{v}(x,t) = \left[v_1(x,t), v_2(x,t), \ldots, v_N(x,t)\right]^T
$$
$$
\mathbf{i}(x,t) = \left[i_1(x,t), i_2(x,t), \ldots, i_N(x,t)\right]^T
$$

are the voltage and the current matrix of the transmission lines respectively. N is the number of multi-conductor transmission lines.

$$
\mathbf{R} = \begin{bmatrix} R_{11} & R_{12} & \cdots & R_{1N} \\ R_{21} & R_{22} & \cdots & R_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ R_{N1} & R_{N2} & \cdots & R_{NN} \end{bmatrix},
$$
$$
\mathbf{L} = \begin{bmatrix} L_{11} & L_{12} & \cdots & L_{1N} \\ L_{21} & L_{22} & \cdots & L_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ L_{N1} & L_{N2} & \cdots & L_{NN} \end{bmatrix},
$$
$$
\mathbf{G} = \begin{bmatrix} G_{11} & G_{12} & \cdots & G_{1N} \\ G_{21} & G_{22} & \cdots & G_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ G_{N1} & G_{N2} & \cdots & G_{NN} \end{bmatrix},
$$
$$
\mathbf{C} = \begin{bmatrix} C_{11} & C_{12} & \cdots & C_{1N} \\ C_{21} & C_{22} & \cdots & C_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ C_{N1} & C_{N2} & \cdots & C_{NN} \end{bmatrix}
$$

are the transmission lines' resistance, inductance, conductance and capacitance respectively per unit length.

Making the transmission lines divided into M equal segments and equation (2) differenced and discredited in spatial domain

$$
\begin{aligned}
\frac{d\mathbf{v}_k(t)}{dt} &= \boldsymbol{C}^{-1}\frac{\mathbf{i}_k(t) - \mathbf{i}_{k+1}(t)}{\Delta x} - \boldsymbol{C}^{-1}\boldsymbol{G}\mathbf{v}_k(t) \\
\frac{d\mathbf{i}_{k+1}(t)}{dt} &= \boldsymbol{L}^{-1}\frac{\mathbf{v}_k(t) - \mathbf{v}_{k+1}(t)}{\Delta x} - \boldsymbol{L}^{-1}\boldsymbol{R}\mathbf{i}_{k+1}(t)
\end{aligned}
\tag{2}
$$

where $\Delta x = l/\mathrm{M}$, $\mathbf{v}_k(t) = \mathbf{v}_k(k\Delta x, t)$, $\mathbf{i}_k(t) = \mathbf{i}_k(k\Delta \mathrm{x,t})$, $k = 0,1, \ldots, M$.

Equation (2) can be written as

$$
\frac{d\mathbf{X}}{dt} = \mathbf{H}\mathbf{X} + \mathbf{F} \tag{3}
$$

in which

$$
\mathbf{X} = \left(\mathbf{v}_0\ \mathbf{v}_1 \ldots \mathbf{v}_{M-1}\ \mathbf{i}_1\ \mathbf{i}_2 \ldots \mathbf{i}_M\right)^T
$$
$$
\mathbf{F} = \left(\mathbf{C}^{-1}\frac{\mathbf{i}_0}{\Delta x} \ldots 0\ 0\ 0\ 0 \ldots -\mathbf{L}^{-1}\frac{\mathbf{v}_M}{\Delta x}\right)^T
$$
$$
\mathbf{H} = \left[\begin{array}{cccc|cccc}
-\mathbf{C}^{-1}\mathbf{G} & & & \mathbf{0} & \mathbf{C}^{-1}\frac{1}{\Delta x} & -\mathbf{C}^{-1}\frac{1}{\Delta x} & & 0 \\
& \ddots & & & & \ddots & \ddots & \\
& & \ddots & & & & \ddots & -\mathbf{C}^{-1}\frac{1}{\Delta x} \\
0 & & & -\mathbf{C}^{-1}\mathbf{G} & 0 & & & \mathbf{C}^{-1}\frac{1}{\Delta x} \\
\hline
-\mathbf{L}^{-1}\frac{1}{\Delta x} & & & 0 & -\mathbf{L}^{-1}\mathbf{R} & & & 0 \\
\mathbf{L}^{-1}\frac{1}{\Delta x} & \ddots & & & & \ddots & & \\
& \ddots & \ddots & & & & \ddots & \\
0 & & \mathbf{L}^{-1}\frac{1}{\Delta x} & -\mathbf{L}^{-1}\frac{1}{\Delta x} & 0 & & & -\mathbf{L}^{-1}\mathbf{R}
\end{array}\right]
$$

Let p be the transmission lines parameters or the terminal load parameters and the partial differentiation of (3) with respect to p yields

$$
\frac{\partial^2 \mathbf{X}}{\partial t \partial p} = \frac{\partial \mathbf{H}}{\partial p}\mathbf{X} + \mathbf{H}\frac{\partial \mathbf{X}}{\partial p} + \frac{\partial \mathbf{F}}{\partial p} \tag{4}
$$

Let $\mathbf{X}_p = \partial \mathbf{X}/\partial p$, (4) becomes

$$
\frac{\partial \mathbf{X}_p}{\partial t} = \mathbf{H}\mathbf{X}_p + \frac{\partial \mathbf{H}}{\partial p}\mathbf{X} + \frac{\partial \mathbf{F}}{\partial p} \tag{5}
$$

The solution of equation (4) is

$$
\begin{aligned}
\mathbf{X}_p(t) &= \exp(\mathbf{H}t)\int_{-\infty}^{t}\exp(-\mathbf{H}\zeta)\left[\frac{\partial \mathbf{H}}{\partial p}\mathbf{X}(\zeta) + \frac{\partial \mathbf{F}(\zeta)}{\partial p}\right]d\zeta \\
&= \exp(\mathbf{H}t)\left\{\int_{-\infty}^{0}\exp(-\mathbf{H}\zeta)\left[\frac{\partial \mathbf{H}}{\partial p}\mathbf{X}(\zeta) + \frac{\partial \mathbf{F}(\zeta)}{\partial p}\right]d\zeta\right. \\
&\quad \left. + \int_0^t \exp(-\mathbf{H}\zeta)\left[\frac{\partial \mathbf{H}}{\partial p}\mathbf{X}(\zeta) + \frac{\partial \mathbf{F}(\zeta)}{\partial p}\right]d\zeta\right\} \\
&= \exp(\mathbf{H}t)\mathbf{X}_p(0) + \int_0^t \exp[(\mathbf{H}(t-\zeta)] \\
&\quad \times\left[\frac{\partial \mathbf{H}}{\partial p}\mathbf{X}(\zeta) + \frac{\partial \mathbf{F}(\zeta)}{\partial p}\right]d\zeta
\end{aligned}
$$

Let $t_j = j\Delta t$, $\mathbf{X}_p^j = \mathbf{X}_p\left(t_j\right)$, $j = 0,1,2,\cdots$, Δt is time step, have

$$
\begin{aligned}
\mathbf{X}_p^{j+1} &= \exp\left(\mathbf{H}t_{j+1}\right)\mathbf{X}_p^0 + \int_0^{t_{j+1}} \exp\left[(\mathbf{H}(t_{j+1}-\zeta)\right] \\
&\quad \times \left[\frac{\partial \mathbf{H}}{\partial p}\mathbf{X}(\zeta) + \frac{\partial \mathbf{F}(\zeta)}{\partial p}\right] d\zeta \\
&= \exp\left(\mathbf{H}\Delta t\right)\mathbf{X}_p^j + \int_{t_j}^{t_{j+1}} \exp\left[\mathbf{H}\left(t_{j+1}-\zeta\right)\right] \\
&\quad \times \left[\frac{\partial \mathbf{H}}{\partial p}\mathbf{X}(\zeta) + \frac{\partial \mathbf{F}(\zeta)}{\partial p}\right] d\zeta \\
&= \exp\left(\mathbf{H}\Delta t\right)\mathbf{X}_p^j + \int_0^{\Delta t} \exp\left(\mathbf{H}\zeta\right) \\
&\quad \times \left[\frac{\partial \mathbf{H}}{\partial p}\mathbf{X}(t_{j+1}-\zeta) + \frac{\partial \mathbf{F}\left(t_{j+1}-\zeta\right)}{\partial p}\right] d\zeta \\
&= \exp(\mathbf{H}\Delta t)\mathbf{X}_p^j + \mathbf{H}^{-1}\left[\mathbf{I} - \exp(\mathbf{H}\Delta t)\right] \\
&\quad \times \left[\frac{\partial \mathbf{H}}{\partial p}\frac{\mathbf{X}^{j+1}+\mathbf{X}^j}{2} + \frac{\dfrac{\partial \mathbf{F}\left(t_{j+1}\right)}{\partial p} + \dfrac{\partial \mathbf{F}\left(t_j\right)}{\partial p}}{2}\right] \qquad (6)
\end{aligned}
$$

It is obvious that the method proposed in this paper did not analyze the sensitivity of the transient responses of the coupled transmission lines directly in equation (6), but transformed it into solving the transient responses of the coupled transmission lines. The study shows that the method used to analyze the sensitivity of the transient responses of the coupled transmission lines based on precise integration is simple and efficient in the time domain [6]. Therefore, the method in this paper greatly simplifies the sensitivity analysis on transient responses of the coupled transmission lines, is a simple method to analyze the sensitivity of transient responses of the coupled transmission lines.

From the above analysis process we can see, this method proceeded in the time domain directly, time step and space step have no effect on the stability of the algorithm, only a certain impact on the precision of the algorithm, the smaller the step length, the higher the calculation precision. Meanwhile, the method proposed in this paper doesn't require decoupling of the coupled transmission lines and a large number of conversions between the frequency domain and the time domain, can be applied to analyze uniform, non-uniform lossy coupled transmission lines and any kinds of loads, is a novel, all-purpose method to analyze the sensitivity of transient responses of the coupled transmission lines.

3 EXAMPLE

Examples taken from literature[1] and the circuit as shown in Figure 1.The length of the transmission

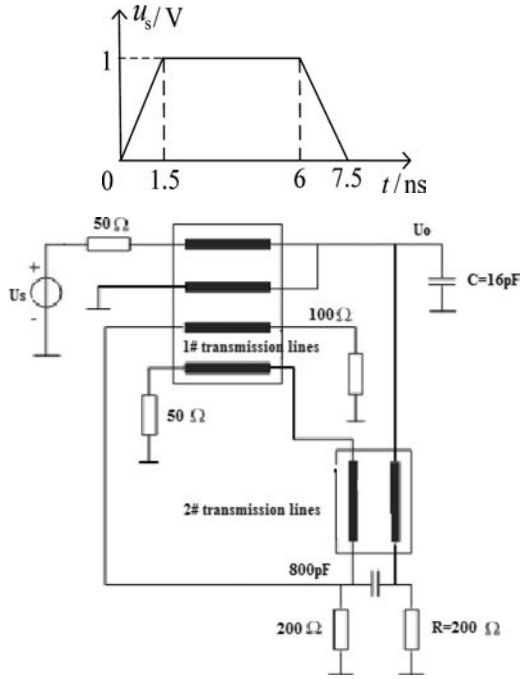

Figure 1. Transmission line system in the example. a) Waveform of the driven. b) Circuit of transmission line system.

lines, 1# and 2#, are 0.3 *m* and 0.4 *m* respectively. The parameters of 1# are R = 0, G = 0.

$$
L = \begin{bmatrix} 1.5 & 0.18 & 0 & 0 \\ 0.18 & 1.5 & 0.18 & 0 \\ 0 & 0.18 & 1.5 & 0.18 \\ 0 & 0 & 0.18 & 1.5 \end{bmatrix} \mu H/m
$$

$$
C = \begin{bmatrix} 0.266 & -0.02 & 0 & 0 \\ -0.02 & 0.266 & -0.02 & 0 \\ 0 & -0.02 & 0.266 & -0.02 \\ 0 & 0 & -0.02 & 0.266 \end{bmatrix} nF/m
$$

The parameters of 2# are R = 0, G = 0

$$
L = \begin{bmatrix} 750 & 95 \\ 95 & 750 \end{bmatrix} nH/m,
$$

$$
C = \begin{bmatrix} 0.133 & -0.009 \\ -0.009 & 0.133 \end{bmatrix} nF/m
$$

Take M = 50, Δt = 50 ns, Figure 2, 3 show the part of the analysis results of the method in this paper and literature [1] respectively. As the figures shown, the parameters, such as amplitude, delay

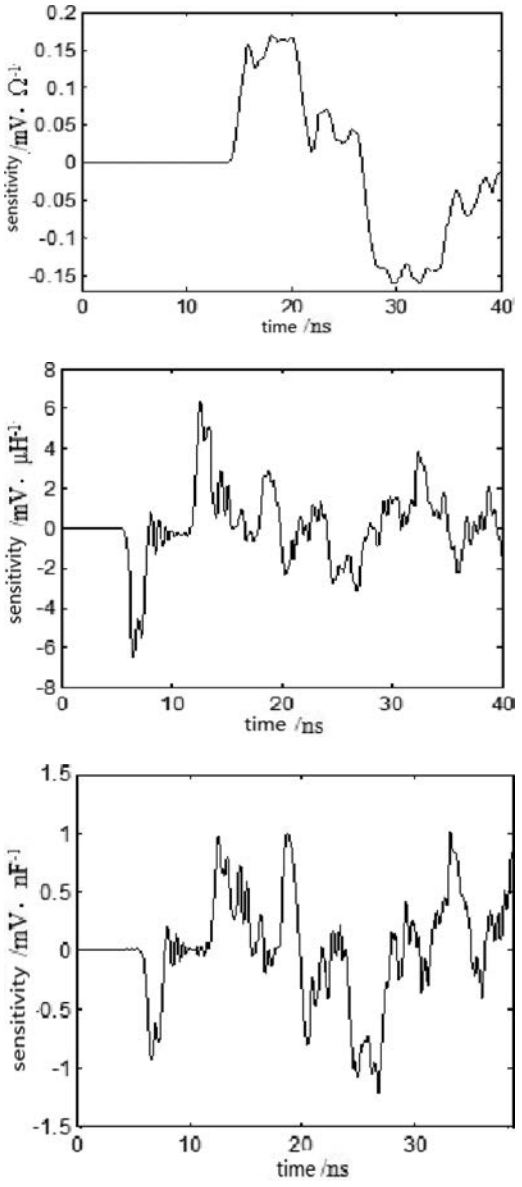

Figure 2. Results of the proposed method. a) Sensitivity of u_o with respect to R. b) Sensitivity of u_o with respect to L_{11} (1.5 μH/m) of 1#. c) Sensitivity of u_o with respect to C.

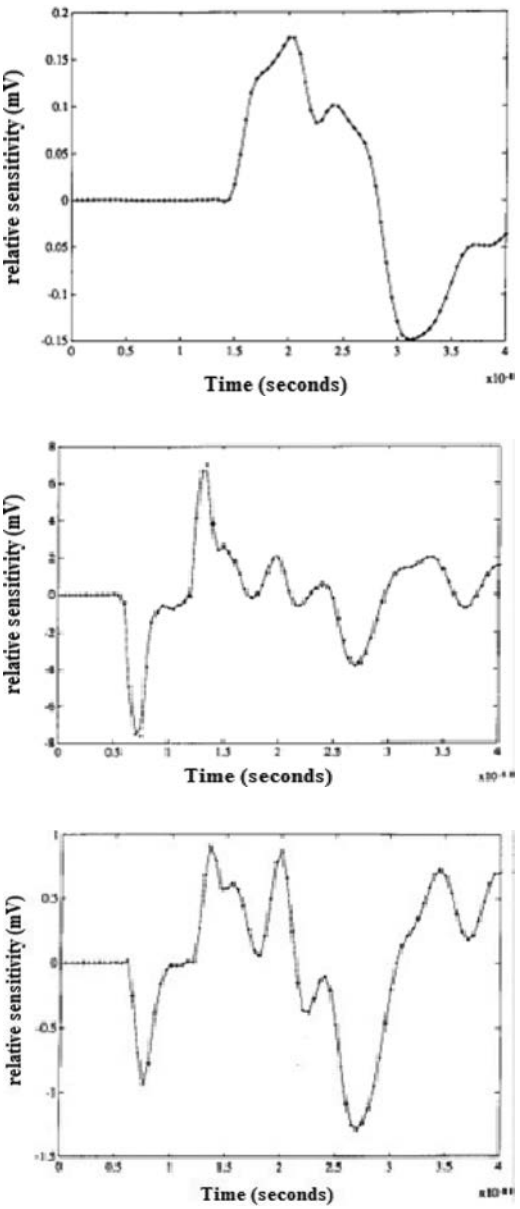

Figure 3. The results of literature [1]. a) Sensitivity of u_o with respect to R. b) Sensitivity of u_o with respect to L_{11} (1.5 μH/m) of 1#. c) Sensitivity of u_o with respect to C.

time, shape, etc., of the sensitivity waveform of these two methods are almost consistent. The sensitivity waveforms have some glitch with the method proposed in this paper, which is due to the smaller M and the larger time step Δt. In order to ensure the authentic results, the method in this paper did not conduct data fitting. Running time turned out to be less than 100 s at M = 100, so the method proposed in this paper have a high computational efficiency. The result shows the consistency of the proposed method with the literature [1].

4 CONCLUSION

Based on the precise integration of sensitivity analysis on transient responses of the coupled transmission lines in the time-domain, the telegrapher's equations of the coupled transmission lines are differenced and discredited in spatial domain and the first order differential equations of the sensitivity of the transient responses of the transmission lines are established, then transform the sensitivity problem into solving the transient responses and the first-order differential equations. The results of the example demonstrate that this method is correct and stable, with efficient and accurate results. This method is easy to compute, and can be applied to analyze the sensitivity of uniform and non-uniform of transmission lines and the arbitrary loads.

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