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The Design of Communication Protocol for Monitoring S7-200 PLC

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Abstract—All existing communication protocols according to which PC monitor PLC is used for special application or too complex to understand and apply. This paper uses flexible receive message control of S7-200 PLC’s free-port, designs a monitoring protocols that is simple, reliable, universal and easily using to special application. This protocol is hexadecimal, transmitting and receiving the same fixed formats. By reading and writing any PLC’s registers, it can achieve the goal of monitoring PLC with PC.

Index Terms — Monitoring Protocol, PLC, Free-port, Xor Check Character, Interrupt

I. Introduction

SIEMENS S7-200 PLC is Programmable Logic Controller that is widely used in small and medium system control, and it is more and more widely applied in industry control field, because it integrates a large number instructions and functions, as well as high reliability, good communication capability and high cost performance. In the industry control system where PC monitors PLC, PLC ,as slave computer, achieves to collect all kinds of signal and data, calculate and control field devices; PC ,as master computer, provides human-computer interaction interface and achieves the field data processing and real-time display, and remote control, etc. PLC and PC can give full play to respective superiority at this monitoring system. However one of the key technique of the monitoring system is how to connect PC and PLC and communicate each other. The connection between PC and PLC in hardware are as follows: firstly, converting PC’s RS-232 to RS-485 with RS-232/485 converter, then, connecting PLC and other field devices with RS-485 interface on RS-485 bus. At this rate PC can remote control all kinds of field devices.

The difficulty is designing the monitoring protocol between PC and PLC [1]. The cost-optimal communication mode is PPI (point to point interface) and free-port among all kinds of the communication mode base on RS-485 serial bus with S7-200 PLC. PPI is a proprietary protocol, not published, and only suitable for communication among SIEMENS products. The free-port communication mode is open to users who can design the communication protocol at will for meeting the various application demands.

There are many existing communication protocols for PC and S7-200 PLC in monitoring system, which are designed for the specific control system, or too complicated to understand, thus make it difficult to be applied universally. This paper directs at the communication port 0 on S7-200 PLC , with its flexible

communication control function of free-port mode, it designs a simple, reliable and high-efficiency monitoring protocol. PC can read and write any registers in PLC by special variable registers, to achieve remote monitoring PLC.

II. Monitoring Protocol

A monitoring protocol is one important part for monitoring system, which affects efficiency and stability of overall system operations. To ensure correct recognition message between PC and PLC, we must make full use of free-port communication control functions of S7-200 PLC. When designing the PLC’s communication program, some follow factors are taken into account to in monitoring protocol [2]:

- a. Protocol data is indicated by hexadecimal number system, and the transmit frame is similar to the receive frame. A PLC’s variables memory takes up to four bytes, so the data field is set as 4 bytes in message frame;
- b. There is a PLC address field in the message frame, so PC can communicate with more than one PLC;
- c. The start of message frame is detected by an idle line condition, and the end of it is controlled by maximum number of characters and a message timer, so that the received frame is ensured to be in full form.
- d. To insure data transmission correctly, use xor check to detect the error code in transmitting procedure [3].
- e. To simplify PLC’s control program and PC’s monitor program, the request frame from PC to PLC is similar with the response frame from PLC to PC.

The request frame that PC transmits to PLC is table I.

TABLE I.
 THE REQUEST FRAME FORMAT

| Bytes | 1 | 1 | 1 | 2 | 4 | 1 |
|-------------|-------------|-------------|------------------|-----------------|------|-----|
| Frame field | PLC address | Read /Write | Type of register | No. of register | Data | FCC |

Here PLC address field is destination address, among 01(value is indicated by hexadecimal number system, the same as below) to FF; In Read/Write field, 00 indicates read data from PLC, 01 indicates write data to PLC; There are three types of value in Type of register field: 00 indicates discrete inputs and image register, 01 indicates discrete outputs and image register, and 02 indicates variable memory; No. of register field indicates read or write number of register; In Data field, when PC gets data from PLC, the 4 bytes is invalid; when PC write data to PLC, the 4 bytes data is valid data that will be written to specific memory; FCC field stores xor check value of all previous bytes in message frame.

The response frame from PLC to PC is similar to the request frame from PC to PLC, and the difference is the meaning of data field. In the response frame where PC reads data from PLC, data field stores 4 bytes data that

starts from No. of register in PLC; In the response frame where PC writes data from PLC, data field stores 4 bytes data that start from No. of register in PLC, and there are also 4 bytes data in the request frame where PC writes to PLC. The PC can verify if the received data to PLC is correct or not.

III. Communication Program

The idea of communication program designing is as follow: PLC always runs in received status in monitoring system. After the whole message frame is received, PLC enters into receive message complete interrupt and handle the received data, and then starts up timed interrupt 0 with a setting time for waiting for transmitter getting ready. PLC transmits data that PC requested in timed interrupt 0 after the setting time. PLC returns received status after data transmission is completed. Notes: only when PLC is in running, can it be set to free-port mode. Once it returns to stop, it will be automatically turning into PPI mode from free-port mode. At this time, STEP 7-Micro/WIN on PC can program PLC.

PLC communication function’s initialization process is as follow:

Firstly, set free-port control registers SMB30, communication port 0 will enter free-port mode in RUN mode. At the same times, set its common communication parameters such as baud rate, data bits, parity bits, etc. For commonality, at this time, set baud rate 9600, data bits 8, no parity, stop bits 1, the same as PC, i.e. SMB30 value is 9 [4].

Secondly, set message receive mode. Receive message control byte SMB78 contains all the ways for receiving message control [5]. In consideration of previous statement message frame format, setting receive message control function includes receive message available, detecting idle line time with SMW90 at 5ms, and detecting message time with SMW92 at 100ms. So the SMB87’s value is 9C. Referring to previous message frame format, there are 10 bytes in one frame, so the maximum number of characters to be received is 10, i.e. SMB94 value is 10.

The xor check is used as FCC in this communication program, the FCC is at the end of the message. When the frame transmits, the receiver checks the message to produce check code and compare it with FCC that is received. If two of them are identical, then continue to the next operation, otherwise, there will be no response. For example, when PLC received message for itself, it check data with xor operation. If FCC is correct, PLC will read or write specified register, otherwise PLC will not respond. The flow chart of initialization program and Interrupt routine is as Fig.1 and Fig.2. The detail program is Appendix A.

IV. The Application of Communication Program

For the easy application of this communication program, variable symbols are defined for all of variable registers that will be used with symbol table in STEP 7-Micro/WIN, reference table 1. When it is used, on the basis of usage of variable memory in PLC control program, relocate variable memory to meet the demand

of application and avoid the conflict between control variable and communication variable. The subroutines in communication program use locate variable to reduce quantity of variable memory, the communication program uses only 11 bytes variable memory, as is shown in table 1. The less use of variable memory, the easier to apply.

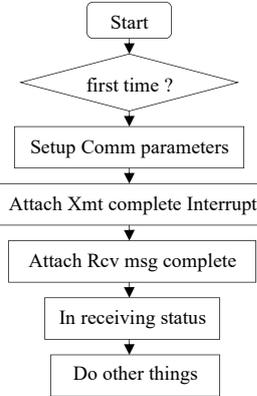


Figure 1. Initialization routine

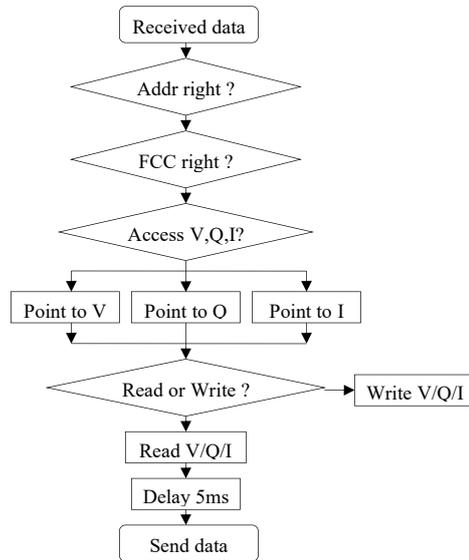


Figure 2. Interrupt routine

TABLE 2
SYMBOL TABLE OF COMMUNICATION PROGRAM

| Symbol name | Variable memory | note |
|-------------|-----------------|---|
| BUFFER | VB60 | Start address of buffer, store No. of receive or transmit |
| BUFADD | VB61 | PLC address |
| BUFRW | VB62 | 0 read and 1 write |
| BUFREG | VB63 | Type of register: 2 for Variable, 1 for Q, 0 for I |
| BUFOFF | VW64 | No. Of register |
| BUFVAL | VB66 | Value for read or write, 4 bytes |
| BUF XOR | VB70 | XOR check code |

When using this communication program to specific PLC control system, initialization subroutine must be called at entry of main routine. Then PC communicates with specific variable register, read or write PLC’s data in field, realize remote control.

V Test

In monitoring system that consists of PC and PLC, the PC monitoring program transmits request message frame

to read or write specific variable memory in PLC based on monitor protocol. The PLC control program makes field control and responses field data. In this test, using common serial communication testing software as PC monitoring program, PLC communication program is modified as control program, such as following instructions to moving current data and time to VB100 and value of analog adjustment 0&1 to VW108. PC monitoring program can get the value of input current time and data, analog adjustment 0&1, or control output by output register.

```
LD SM0.1 // entry running mode
CALL SBR0 // call initialization subroutine
TODR VB100 // current data and time to VB100
MOVW SMW28, VW108 // value of analog adjustment 0&1 to VW108
```

When PC transmits writing output register frame “02 01 01 00 00 04 05 04 05 02”, PLC’s Q0.2, Q1.0, Q1.2 led turn on, corresponding 04 05, and PC receives the same frame, these indicate this writing function is validity. When PC transmit reading input register frame “02 01 01 00 00 04 05 04 05 02”, it receives the frame “02 00 00 00 00 08 00 00 00 0A”. Here 08 is in correspondence with PLC’s I0.3 in height consistent with the fact. When PC transmit reading VB100 variable register frame “02 00 02 00 64 01 02 03 04 60”, it receives the frame “02 00 02 00 64 13 10 11 21 57”, here 13 10 11 21 means date 13-10-11 and hour 21 as current date and time. After adjusting analog adjustment 0&1 to 100 and 200, PC transmit reading VB108 variable register frame “02 00 02 00 64 01 02 03 04 68”, then it receives the frame “02 00 02 00 6C 64 C8 00 00 C0”, here 64(decimal number 100) and C8(decimal number 200) is current value of analog adjustment 0&1 as adjusting. All of above prove the communication program’s validity and reliable.

VI. Conclusion

This paper designs a common PLC’s communication program for monitoring system by using free-port of S7-200 PLC; it occupies fewer PLC’s memory resources, and defines them by symbol table. Therefore, it is easy to modify. This monitoring protocol is simple, reliable, and easy to understand. These advantages make it easy to be used to specific monitoring system consisting of PC and PLC. This communication program is already used in solar energy hot-water monitoring system, and it is reliable and operates well.

Appendix A Appendix Title

1. Initialization subroutine

```
LD SM0.0
MOVB 9, SMB30
MOVB 16#9C, SMB87
MOVW 5, SMW90
MOVW +100, SMW92
MOVW 10, SMB94
ATCH RCV INT:INT0, 23
ATCH SEND_INT:INT1, 9
ENI
RCV BUFFER:VB60, 0
```

2. Receive message complete interrupt subroutine

```
LD SM0.0
AB<> BUFADD:VB61, 16#02
JMP 1
NOT
CALL FCS:SBR1, &BUFADD:&VB61,
9, #XORCODE:LB0
LDB= #XORCODE:LB0, BUF XOR:VB70
LPS
AB= BUFREG:VB63, 2
MOVD &VB0, #RWADD:LD7
AB= BUFREG:VB63, 1
MOVD &QB0, #RWADD:LD7
AB= BUFREG:VB63, 0
MOVD &IB0, #RWADD:LD7
MOVW BUFOFF:VW64, #OFFADD W:LW1
ITD #OFFADD W:LW1, #OFFADD D:LD3
+D #OFFADD D:LD3, #RWADD:LD7
AB= BUFRW:VB62, 0
BMB *#RWADD:*LD7, BUFVAL:VB66, 4
AB= BUFRW:VB62, 1
BMB BUFVAL:VB66, *#RWADD:*LD7, 4
BMB *#RWADD:*LD7, BUFVAL:VB66, 4
LPP
MOVW 5, SMB34
ATCH TIMER_INT_0:INT2, 10
CRETI
LBL 1
LD SM0.0
RCV BUFFER:VB60, 0
```

3. Timed interrupt 0 subroutine

```
LD SM0.0
DTCH 10
CALL FCS:SBR1, &BUFADD:&VB62,
9, BUF XOR:VB71
XMT BUFFER:VB60, 0
```

4. Transmit complete interrupt subroutine

```
LD SM0.0
RCV BUFFER:VB60, 0
```

5. Xor check subroutine

```
LD SM0.0
MOVB 0, #XORCODE:LB6
FOR #TEMPINDX:LW7, +1,
#BYTENUM:LW4
LD SM0.0
XORB *#STARTADD:*LD0,
#XORCODE:LB6
INCD #STARTADD:LD0
NEXT
```

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Application of the Fractional Order $PI^\lambda D^\mu$ Controller With Neural Network In The Inverter Power Supply

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Abstract—The mathematical model of three-phase bridge inverter power supply is established. The fractional order $PI^\lambda D^\mu$ controller is introduced into the control system of the three-phase bridge inverter power supply. The 5 parameters of the controller are self-tuned online by the algorithm of BP (Back Propagation) neural network. Then, the fractional order $PI^\lambda D^\mu$ control system with learning features of neural network is proposed for the three phase bridge inverter power supply. Finally, the simulation model is built in MATLAB/Simulink. And the simulation results show that the quality of the output voltage waveform of the inverter power supply controlled by the neural network fractional order $PI^\lambda D^\mu$ controller is better than another case which is controlled by the traditional PID (Proportion, Integral and Differential) controller. The control strategy is suitable for the control system of three-phase bridge inverter power supply.

Index Terms—inverter power supply, fractional order, BP neural network, self-tune online

I. INTRODUCTION

The device called inverter power supply is used to transform the direct current into the alternating current with constant frequency and steady voltage. With the development of society and technology, the inverter power supply has been widely used in the fields of ships, aerospace, finance, communications, industry and transportation. The main reasons of the distortion of the output voltage waveform of the inverter power supply include the change of load, the influence of the external disturbance and the dead zone of the switching device. The performance of the inverter power supply is directly determined by the ability of the control system to inhibit the distortion of the output voltage waveform. Scholars at home and abroad have proposed many control strategies and achieved some great results, such as digital PID control [1,2], feedback control [3], repetitive control [4,5], intelligent control [6-8], sliding mode variable structure control [9], robust control [10-12] and so on. But each control strategy has its limitations and its control effect is difficult to fully meet the high performance requirements of inverter power supply, such as the state feedback control need for the accurate mathematical model of the inverter power supply, and the performance of the dynamic response of the repetitive control is very poor. The largest advantage of fractional order $PI^\lambda D^\mu$ control is the memory and heredity of the controller, furthermore, it is more flexible, stable and robust than the traditional PID

control by added the differential and integral order. The parameters of fractional order $PI^\lambda D^\mu$ controller are self-tuned online by the neural network with its properties of adaptive, self-learning and self organization. Then, the neural network fractional order controller is established for the application of the control of some nonlinear complex systems. And it will have more excellent performance and wider application prospect.

II. THREE PHASE BRIDGE INVERTER POWER SUPPLY

The topology structure of three-phase bridge inverter power supply is shown in Figure 1. Among them, the E_d is the input DC voltage source, the Q_1-Q_6 are the IGBT switch tube, the L and C are respectively the filter inductor and filter capacitor of the output low pass filter, the R is the equivalent series resistance of the low pass filter.

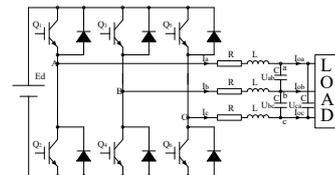


Figure 1. The topological structure of three-phase bridge inverter power supply. The mathematical model of the three-phase inverter power supply can be obtained by Figure 1:

$$\begin{aligned} \dot{x} &= Ax + Bu \\ y &= [1 \ 1 \ 1 \ 0 \ 0 \ 0]x \end{aligned} \tag{1}$$

Where,

$$x = [U_{ab} \ U_{bc} \ U_{ca} \ I_a \ I_b \ I_c]^T, \quad u = [U_A \ U_B \ U_C \ I_{oa} \ I_{ob} \ I_{oc}]^T,$$

$$A = \begin{bmatrix} 0 & 0 & 0 & \frac{1}{3C} & -\frac{1}{3C} & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{3C} & -\frac{1}{3C} \\ 0 & 0 & 0 & -\frac{1}{3C} & 0 & \frac{1}{3C} \\ -\frac{1}{3L} & 0 & \frac{1}{3L} & -\frac{R}{L} & 0 & 0 \\ \frac{1}{3L} & -\frac{1}{3L} & 0 & 0 & -\frac{R}{L} & 0 \\ 0 & \frac{1}{3L} & -\frac{1}{3L} & 0 & 0 & -\frac{R}{L} \end{bmatrix},$$

$$B = \begin{bmatrix} 0 & 0 & 0 & -\frac{1}{3C} & \frac{1}{3C} & 0 \\ 0 & 0 & 0 & 0 & -\frac{1}{3C} & \frac{1}{3C} \\ 0 & 0 & 0 & \frac{1}{3C} & 0 & -\frac{1}{3C} \\ \frac{2}{3L} & -\frac{1}{3L} & -\frac{1}{3L} & 0 & 0 & 0 \\ -\frac{1}{3L} & \frac{2}{3L} & -\frac{1}{3L} & 0 & 0 & 0 \\ -\frac{1}{3L} & -\frac{1}{3L} & \frac{2}{3L} & 0 & 0 & 0 \end{bmatrix}$$

III. NEURAL NETWORK FRACTIONAL ORDER CONTROLLER

A. Fractional order controller

The mathematical description of the integer order PID controller is:

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{de(t)}{dt} \quad (2)$$

Where, the K_p, K_i, K_d are respectively the coefficient proportion, integral, differential of the controller. The $e(t)$ is the output error of the whole system. Correspondingly, the fractional order $PI^\lambda D^\mu$ controller [13] is described as:

$$u(t) = K_p e(t) + K_i D_t^{-\lambda} e(t) + K_d D_t^\mu e(t) \quad (3)$$

Where, the $\lambda > 0$ and $\mu > 0$ are respectively the differential and integral link. Fractional calculus operator is defined as follow:

$$D_t^\alpha = \begin{cases} \frac{d^\alpha}{dt^\alpha}, & \alpha > 0 \\ 1, & \alpha = 0 \\ \int_0^t (d\tau)^{-\alpha}, & \alpha < 0 \end{cases} \quad (4)$$

Where, it expresses as a differential operator when the fractional order α is positive and as an integral operator when the fractional order α is negative. The fractional calculus is defined by the Grünwald-Letnikov definition as [14]:

$$D_t^\alpha f(t) = \lim_{h \rightarrow 0} \frac{1}{\Gamma(\alpha) h^\alpha} \sum_{j=0}^{\lfloor t/h \rfloor} \Gamma(\alpha + j) f(t - jh) \quad (5)$$

When the h is small enough, the discretization fractional order $PI^\lambda D^\mu$ controller is:

$$u(k) = K_p e(k) + \frac{K_i h^\lambda}{\Gamma(-\lambda)} \sum_{j=0}^k \frac{\Gamma(j-\lambda)}{\Gamma(j+1)} e(k-j) + \frac{K_d h^{-\mu}}{\Gamma(\mu)} \sum_{j=0}^k \frac{\Gamma(j+\mu)}{\Gamma(j+1)} e(k-j) \quad (6)$$

B. BP neural network fractional order $PI^\lambda D^\mu$ controller

The BP neural network algorithm is a multilayer feedforward neural network. Its basic idea is the least squares method and error back-propagation which is used to solve the weights and thresholds of each layers to reach the minimum error between the actual and expected output value of the network. The BP neural network structure is established as shown in Figure 2. The input of the network includes the input signal r of the system, output signal y and error signal e . And the output includes the 5 parameters $K_p, K_i, K_d, \lambda, \mu$ of the $PI^\lambda D^\mu$ controller. The network self-tunes online the parameters according the input signals. Therefore, the number of neurons in the input layer and output layer are 3 and 5 respectively.

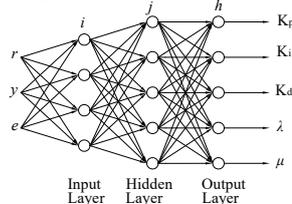


Figure 2. BP neural network structure diagram

(1)The input layer: The input signals of BP neural network are the input signal r , output signal y and error signal e .

$$O_i = [r, y, e], i = 1, 2, 3 \quad (7)$$

(2)The hidden layer: The input and output of the hidden layer of BP neural network respectively show as:

$$net_j = \sum_{i=1}^l w_{ij} O_i - b_j \quad (8)$$

$$O_j = f_j(net_j), j = 1, 2, \dots, m$$

Where, the m represents the number of neurons in the hidden layer. The conversion function $f(*)$ is an odd function called Sigmoid:

$$f_j(x) = \tanh(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}} \quad (9)$$

(3)The output layer: The outputs of the BP neural network are the 5 self-tuning parameters of the fractional order $PI^\lambda D^\mu$ controller.

$$net_h = \sum_{j=1}^m w_{jh} O_j - b_h \quad (10)$$

$$O_h = f_h(net_h), h = 1, 2, \dots, 5$$

Where, the conversion function $f(*)$ is a non-negative function called Sigmoid:

$$f_h(x) = \frac{1}{2} [1 + \tanh(x)] = \frac{e^x}{e^x + e^{-x}} \quad (11)$$

The performance index function is defined as follow:

$$E(k) = \frac{1}{2} e^2(k) \quad (12)$$

The weight coefficient and threshold of the network are corrected by the gradient descent method. A momentum term is added into the learning algorithm to make the convergence of the learning process faster [15,16]. Then the learning algorithm of neural network can be described as follows:

$$\begin{aligned} \Delta w(k) &= -\eta \frac{\partial E(k)}{\partial w} \\ \Delta b(k) &= -\eta \frac{\partial E(k)}{\partial b} \end{aligned} \quad (13)$$

$$w(k) = w(k-1) + \Delta w(k) + \beta \Delta w(k)$$

$$b(k) = b(k-1) + \Delta b(k) + \beta \Delta b(k)$$

Where, the constants η and β are respectively learning rate and momentum factor.

The learning algorithm of BP neural network is introduced into the controller for the self-learning of the control system. The parameters $K_p, K_i, K_d, \lambda, \mu$ are self-tuned online by the fractional controller based on the BP neural network, finally. The neural network fractional $PI^\lambda D^\mu$ control system as shown in Figure 3 can be established for the three-phase bridge inverter power supply.

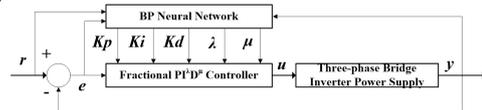


Figure 3. Block diagram of the control system

IV. SIMULATION EXPERIMENTS AND RESULTS ANALYSIS

The simulation programs of three-phase bridge inverter power supply system (Figure 4) and BP neural network fractional order $PI^\lambda D^\mu$ control system (Figure 5) are established by MATLAB/Simulink. The neural network fractional order controller is realized by two Level-2 MATLAB S-Function. The parameters of the fractional order controller are online self-tuned by the first one, and the output of the fractional order $PI^\lambda D^\mu$ controller is calculated by the second one. The DC input voltage source of the inverter power supply is 600V and the rated

voltage of the AC output terminal is 220V/400Hz. The output voltage waveform of the inverter power supply under the control of the traditional integer order PID controller and the BP neural network fractional order $PI^{\lambda}D^{\mu}$ controller are respectively shown in Figure 6 and Figure 7.

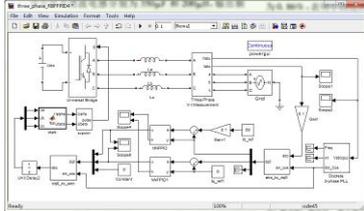


Figure 4. Three-phase bridge inverter power supply system simulation program

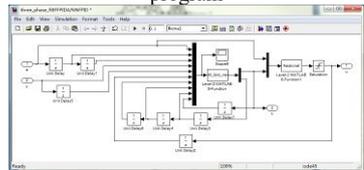


Figure 5. Neural network fractional order controller

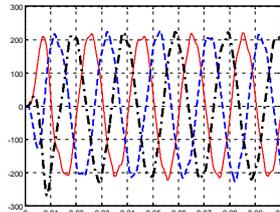


Figure 6. Effect of traditional integer order PID control

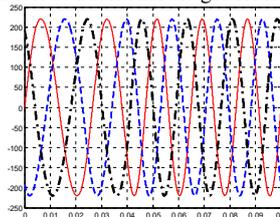


Figure 7. Effect of BP neural network fractional order $PI^{\lambda}D^{\mu}$ control

According to the Fig. 6 and Fig. 7, it can be seen that there exists a serious distorted in the output voltage waveform of the inverter power supply controlled by the traditional integer order PID control, correspondingly, there is almost no distortion of the inverter power supply controlled by BP neural network fractional order $PI^{\lambda}D^{\mu}$ control and its sine degree is very great. The online self-tuning of BP neural network for the five parameters of the controller effectively suppresses the distortion of output voltage waveform of the inverter power supply. The control system meets the performance requirements of the inverter power supply.

V. CONCLUSION

The BP neural network fractional order $PI^{\lambda}D^{\mu}$ control system of three-phase bridge inverter power supply is established. The results of simulation experiment show that the quality of output voltage waveform of the inverter power supply controlled by the BP neural network fractional order $PI^{\lambda}D^{\mu}$ control is great. The Control Strategy is suitable for the control system of three-phase bridge inverter power supply.

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Research And Application Of Bridge Reinforcement

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Abstract—Vigorous development of highway construction enterprise in our country, road network is perfect with each passing day, gradually reduce the new bridge, built bridge repair, maintenance, reinforcement and reconstruction has become the working centre of gravity of the road transport sector. The paper focuses on the four kinds of commonly used bridge reinforcement method (carbon fiber reinforcement, reinforcement with bonding steel plates, external prestressing, increase cross-section reinforcement), introduces the common diseases of bridge and its reasons, the reinforcement methods of bridge system of induction, summarize, analyze, refine, and puts forward the reinforcement scheme comparison and selection should follow the principle.

Index Terms—bridge reinforcement , reinforcement method, economic performance

I. INTRODUCTION

In recent years, the rapid development of transportation industry, the rapid development of highway construction, the rapid increase in the number of bridges, with a total length of, but due to the design, construction, maintenance, overloading and other reasons, bridge safety situation is not optimistic. Over the bridge survey, our country bridge has a considerable part in the "sick" work even in the "dangerous" state. Although every year to arrange a lot of money for the crisis of national and provincial highway old bridge transform and upgrade their technology, but with the rapid development of the economy of our country, in recent years our country highway traffic volume and cycling load weight showed a trend of rapid growth, and the early completion of the load grade low (steam 20 below) total number of bridges more, especially on the rural highway bridge, resulting in highway bridges in danger bridge ratio did not fall but rise [1]. The existence of dangerous bridge, the influence on traffic safety, we must reinforce and repair, with the rapid increase of the recoverable amount of the highway bridge, bridge strengthening maintenance scale is getting bigger and bigger, investment increased year by year, has formed a certain size of the market. Danger and old bridge reinforcement improves the carrying capacity of the structure, improve the bridge capacity, making the entire route is more smooth, greatly improve the existing traffic conditions, will on society, economy and produce certain influence. China's economy is not developed, maintenance of a shortage of funds, strengthen the bridge strengthened economic benefits evaluation method

research, to determine the bridge reinforcement project is reasonable, economy, for the future bridge reinforcement project provides technical and economic guide, let the limited funds to play a greater efficiency.

II. THE CONCEPT AND CHARACTERISTICS OF BRIDGE REINFORCEMENT

Reinforcement is a measure to improve the capacity of the whole bridge by strengthening or increasing the bridge structure. Reinforcement can be carried out by means of different techniques, and the load bearing capacity of the bridge can be reduced, and the structure type and the use requirements are determined. Reinforcement has its own characteristics:

A. The economic effect of bridge reinforcement is often better than the new bridge

Construction of new bridge is time-consuming and laborious, and the cost is high, but the cost of reinforcement is saved. However, the impact of the original traffic should be reduced as far as possible.

B. Bridge reinforcement should make the original structure to play the biggest effect

Bridge reinforcement should be carried out in the first bridge of the detection and assessment, the rational use of the original structure, so that the economic benefits of the original bridge play to maximize.

C. Many new construction techniques have emerged in bridge reinforcement

Bridge reinforcement work is also a few years ago, there are many new processes. Therefore, the scientific nature, rationality and durability of the process must be tested by a large number of engineering practices. It is also necessary to further understand and understand the mechanism of reinforcement, and to lay a foundation for the emergence of new type of reinforcement technology.

D. The standard and the standard used by the original design are different

Reinforcement of the old bridge design is limited by the times, the standards can only meet the need at the time, and can not meet the requirements to use in the future, so reinforcement using standard than the original design by load standards to improve a grade. In order to ensure the safety and durability of the bridge, we should correctly grasp the relevant load standard requirements of the reinforcement.

III. RESEARCH ON MECHANICAL PROPERTIES AND STRENGTHENING MECHANISM OF COMMON BRIDGE REINFORCEMENT METHOD

In this paper, four methods are mainly used to study the reinforcement of the bridge: the carbon fiber reinforcement method, the reinforcement method of the bonded steel plate, the externally prestressed reinforcement method, and the method of increasing the cross section. By studying the mechanical characteristics of these four kinds of strengthening methods, the formula for strengthening the reinforcement is given, and the construction technology of these four methods is analyzed in detail[2].

A. Bonded carbon fiber reinforcement method

Carbon fiber material and binder must be supplied by the supplier, and the performance index of the material is given at the same time. Carbon fiber material has light weight, high tensile strength, adhesive, convenient, time-saving advantage, to improve structure flexural capacity, shear force, compressive bearing capacity various reinforcement methods. In the use of this method, we should pay attention to the effect of the environment on carbon fiber and adhesive, so that the carbon fiber and the binder are in a suitable environment.



Figure 1. Bonded carbon fiber reinforcement method

B. Bonded steel plate reinforcement method

Bonded steel plate reinforcement method is to improve the bearing capacity of the concrete structure by using the configuration of the bonding agent to the surface of the concrete structure. The role of steel plate is equivalent to concrete increase in part by the tensile reinforcement, reinforcement plate generally use the No. 3 steel or 16 manganese steel is appropriate. On the steel plate, the steel plate and the concrete surface have good bonding ability, so as to ensure the joint work between the steel plate and the structure.



Figure 2. Bonded steel plate reinforcement method

C. External prestressing reinforcement method

Prestressed reinforcement method is refers to the application of prestressed tendons in beam and the lower edge of the tension zone, through a pull pre pressure on the beam, the beam forming arch anti bending moment offset load internal force and improve the bridge force, so as to improve the ability to use and ultimate bearing capacity of old bridge. In fact, the external prestressing method has changed the mechanical system of the original structure, which is similar to that of the non bonded prestressed concrete. This method has the construction is simple, to traffic disturbance is small, the human has the characteristics of less investment, bridges strengthened with external prestressing can obviously raise or recover the carrying capacity, satisfy the traffic needs.



Figure 3. External prestressing reinforcement method

D. Increasing section reinforcement method

The reinforcement method is through in the concrete structure of the original surface increase part of concrete, increase the size of the components of the original and the newly added concrete and old concrete can work together, doing so can be very intuitive and effective to enlarge member of highly effective and improve the stiffness of the component, so that the whole bridge bearing capacity is improved, the reinforcement method of girder bridge's reinforcement is widely used.



Figure 4. Increasing section reinforcement method

IV. ECONOMIC BENEFIT ANALYSIS OF BRIDGE REINFORCEMENT

A. Benefit of transportation cost savings

The benefit of transportation cost saving is that the benefit of the bridge is reduced, which makes the cost of goods and transportation cost lower. Bridge reinforcement and reconstruction if improving the existing transportation conditions and increase the traffic capacity of the bridge will bring the improvement of vehicle load, and shipping rates, such as the use of benefit, further reduce transportation costs, and from other related courses or other means of transport

transferred from the AC flux because transport distance shortened to produce lower transportation costs benefit [3]. The benefit of transportation cost savings include reducing the cost of freight transportation and reducing the benefits of B_{hj} and B_{kj} .

B. Benefit of transportation time

The benefit of saving the time of the passengers, goods and vehicles is the benefit of saving the time of transit. Generally speaking, the length of the bridge is not too large, and the vehicle speed relatively faster, vehicles on the bridge stay time shorter, small economic benefits generated by the normal traffic. To separate small bridge reinforcement project post evaluation will not be considered. Induced traffic volume is not the original, it will not produce the benefit of transportation time. Therefore, only consider the transfer of traffic generated by the time of the transport of the benefits [4]. At the time of calculation, the time of transportation is the whole route for the bridge. Because bridge before strengthening due to the bridge carrying the limitation of ability or traffic conditions, people can not or do not want to use the road, after reinforcement makes people can use this way to produce the transport time savings must be distinguished from the whole road transport time saving benefits is not due to the bridge reinforcement and produce. This part includes 3 parts: the benefit of saving the time of passenger transport, the benefit of B_{kt} , the benefit of B_{ht} , and the benefit of the vehicle in transit time B_{ct} .

C. Reduction of traffic accidents

The improvement of traffic conditions and traffic conditions will inevitably reduce the occurrence of traffic accidents and its loss, resulting in the reduction of traffic accidents B_{jsh} . Calculate the number of times and the value of the reduction in the number of accidents caused by the reduction of traffic accidents. Including the traffic accident loss due to traffic accident destroyed vehicles and marketable, bridge damage caused by the loss, including the casualties caused by the loss and mass transport and traffic capacity caused by bumps, collision caused by the damage to the cargo.

D. Ease traffic congestion

If the bridge does not carry out the maintenance and reinforcement, the original route of the mixed traffic volume may continue to increase, the average speed of the corresponding reduction, the unit transportation costs are also increased [5]. Due to the reinforcement of bridge widening project implementation, the original related road traffic volume change after reducing congestion, may improve the transportation cost per unit will no longer increase or even decrease, thus forming ease traffic congestion benefits, including freight benefit B_{hy} and passenger benefit B_{ky} .

E.Reducing the expected value of the failure loss of bridge reinforcement

The bearing capacity of the bridge is improved, the structure performance is improved, the failure probability

is greatly reduced, and the failure loss expectation value is also reduced, so as to produce a certain economic benefit B_p . The direct economic benefit of bridge reinforcement is above all, that is, $B_z=B_{hj}+B_{kj}+B_{ht}+B_{kt}+B_{ct}+B_{jsh}+B_{hy}+B_{ky}+B_p$.

V. CONCLUSION

With the progress of science and technology, bridge reinforcement method will be more and more advanced, the traditional reinforcement methods in addition to its convenient, material economy and continue to get the favour, the new bridge reinforcement method will be from materials and strengthening technology as a starting point, the future bridge reinforcement would certainly will bring a new revolution. In addition, the evaluation of the effect after reinforcement is one of the key points in our future research. Select the best reinforcement form to make optimal control, efforts to improve the efficiency of reinforcement, as we bring the maximum economic benefit and social benefit, this is our engineering staff in a forward direction, I believe the next to the bridge reinforcement method research will have even broader prospects.

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Hierarchical Experimental Teaching System of Internet of Things Engineering

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Abstract—This paper discusses the experimental teaching system construction of Internet of Things Engineering in local application colleges, proposing a hierarchical practice teaching system, building a multi-level education system, including basic experiment, comprehensive experiment, practice project and innovative experiment. This kind of hierarchical practice teaching system enhances students' practical ability and innovation ability, while improving students' employability and competitiveness.

Index Terms—hierarchical, experimental teaching system, internet of thing

I. INTRODUCTION

Internet of Things (IoT) is called the third wave of information industry, and it's rapidly developing [1]. In recent years, universities have also set up IoT engineering. To train qualified IoT engineers, it is highly emergent to build a practice teaching system of IOT Engineering.

This article is written in this context [2-4]. The significance of the article is as following: it puts forward a practice teaching model to meet the demands of market. At present, many laboratories mainly emphasize on the individual skills and qualities, lacking practical experimental courses, this article is to propose solutions[5]. Through the hierarchical experiment system construction, it is possible to improve teaching and research level, as well as students' application and engineering capabilities, and to promote students' employment fundamentally[6].

II. REVIEW WORKS

The existing IoT engineering studies focus on professional development, curriculum construction and excellent engineer training etc. [7-8]. IoT is an emerging national strategic industry. A large number of high-level talents with strong theoretical knowledge and practical skills are badly needed. To meet the demand for networking talents, a hierarchical experimental teaching platform based on IoT fundamental experimental platform proposed. IoT integrated experimental platform, experimental platform, IoT technology research experimental platform and IoT technology demonstration platform[9]. As can be seen from these related work, these studies have focused on the construction of the laboratory itself, they didn't build the teaching system from the perspective of the intrinsic features of IoT technology.

III. HIERACHICAL PRACTICE TEACHING SYSTEM

A. Framework

By analyzing the connotation and extension of IoT engineering, investigating the enterprise demand for IoT professionals, the author set up a scientific training objective to guide constructing practice teaching system. Via the research of IoT personnel employed direction and the corresponding technical requirements of the post, an IoT practice teaching system was built in accordance with the perception layer, transport layer and application layer of the three-level framework. Typical IoT application scenarios and cases were set to promote the students' professional skills, thereby realizing an innovative multi-level test system which covers teaching theory, integrated applications, the principles of validation, and independent design.

B. Construction of Hierarchical Practice Teaching System

Consulting IoT specialized training plan of relevant universities and requirement for students' training program engineering knowledge and practical ability system, we provide multi-level, three-dimensional experiment content with the experimental forms of principle proof, application training, comprehensive analysis, design and innovation of independent research and so on. According to the content of experiments, the experiments can be divided into two large categories, basic course experiments and industrial application experiments. All experimental content adopt modular design and can be expanded immensely according to the developing trend and market demand of IoT technology.

Based on the above ideas of layered and modular construction, we construct the lab with two parts, IoT experimental teaching platform and application training scenarios, when we started to design and establish a lab. Through a variety of experimental operation of the platform, students achieve professional learning of IoT curriculum system, which lay a solid foundation of professional skills. On the basis of experimental teaching curriculum, an application scenarios platform was constructed which covers multiple networking scenarios such as smart home, intelligent building, robot control, industrial monitoring and other networking scenarios display environment. This kind of practice teaching system enables students to intuitively understand the specific application of IoT industry, and enhance the actual development of IoT engineering with the use of open interfaces. It can raise the level of students'

comprehensive application, improve their networking skills and comprehensive engineering capabilities.

Based on the above analysis, IoT practical teaching system can be divided into four levels, namely basic experiment, comprehensive experiment, practice projects and innovative experiment.

1. Basic experiment

After learning some fundamental courses and doing some basic experiments, students are able to master the use of embedded development platform, including the use of single-chip timers, interrupts and serial communication. Students can acquire sensor signals with CC2530 and corresponding module, and know how to use control sensor.

2. Comprehensive experiment

As for the comprehensive courses such as IoT short-range wireless communication, we offer experiment of Z-STACK point and ZSTACK star network communication to help students master IoT communications technology and terminal technology development skills.

3. Practice project

Introducing the knowledge of IoT technology to real projects, setting comprehensive networking system. Currently, the lab is equipped with the projects such as smart home, smart agriculture and food traceability and so on, so that students can grasp IoT integrated design and development skills.

4. innovative experiment

For today's National Undergraduate Electronic Design Contest, Internet of Things Contest and other technology contest, we set a variety of innovative experiments for outstanding students, encouraging them do research project to further enhance students' engineering ability by participating in the competition.

C. Goals for hierarchical teaching practice

Through the researches on IoT industry chain, market demand, professional training and hierarchical laboratory building programs, we made a clear direction for IoT experiment construction and professional training. The main objectives are as follows:

1. Build a hierarchical experimental system with different levels of experimental content and comprehensive test scenarios according to the market demand for IoT professionals, making the experiments meet the demand of industry and promoting students' employment.

2. Standardize the IoT experimental curriculum through specific design, and achieve students' daily experiment management with appropriate management platform, thereby effectively raise teachers' experimental and researching level.

3. Apply the research findings to the Internet of Things Engineering, which can not only make full use of existing laboratory resources and related information,

meeting the needs of teachers' research and students' practical experiments, but also build a bridge between students and businesses with maximum extent.

IV. CONCLUSION

This article discusses the construction of practice teaching system of IoT from a brand new perspective. Experiments are arranged in a hierarchical experiment system according to market demand and job requirements, narrowing the gap between new teaching professional practice and the needs of society. At the same time it simplifies the experimental curriculum, promotes practice teaching management and solves many other problems. Optimizing the IoT experiment course system in hierarchical framework leads to a market-oriented practice teaching training model change, and provides a new idea for the personnel training of new industries.

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Large Coastal Excavated Port Overall Drainage And Relief Technology Research

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Abstract—Wharf stability research is including port key drainage technique research, port key techniques of drainage is a main aspect of study on prevention of geological calamity. A large number of researches indicate that groundwater flow is a direct factor of bank's losing stability and quay structure's slipping damage. According to the engineering field's hydrogeological conditions and distribution of coastal biological data, we use economic and technical parameter to compile and optimize the draining water design plan, combine with the actual situation in construction process of research and formulate reasonable drainage measures, through the field measurements, observation, the accumulation of data and theory analysis, we can timely adjust, improve the construction plan, and summarize the rule. Through the topic research, it can contribute to a solid technical foundation of the project and similar projects, and achieve favorable economic and social benefits. The research on drainage technology is instructive for quay stability analysis and geologic calamity prevention and control.

Index Terms—overall drainage and relief; quay; drainage technique

I. OVERVIEW

In the conditions allow, we should give priority to dry excavation construction for the excavation of excavated basin. According to the analysis of geological data, double layer water stratum has an effect on engineering construction, double layer water stratum includes Tertiary limestone and quaternary sediments (EIA2011) which is located above Tertiary limestone. The project is Based on the area of other engineering projects' experience, The experience is that limestone presents Karst landform (GEMS 2008), the stratum's water on the space distribution is extremely uneven. At the same time, the underground water level is higher, sand's and Limestone double impermeable layer's underground water has close links to the seawater hydraulic. To achieve deep foundation pit construction requirements, water level drawdown is big, water is also huge. As a result, draining engineering constraints become the key to develop smoothly.

The project is a excavation inside the port, terminal shoreline is 7845 meters long, Breakwater is 2.76 km long, the project has About 65 million cubic meters earthwork excavation. Wharf structure is gravity type square dock, Precast and cast-in-place concrete volume is about 1.4 million cubic meters, The diamonds' layer of container terminal is 11, The project maximum digging deep is 19.7 meter. Port bottom elevation is -17 meter. According to the construction plan, basin, pier base trough and within the breakwater base tank foundation have 4 million m² area to adopt dry construction excavation, drainage work directly restricts the implementation of the project schedule.

At the same time, Sand's and Limestone double impermeable layer's underground water has close links to the seawater.

Due to lack of awareness of limestone which is covered above the region sedimentary sand double-layered foundation penetration ability and the connection between seawater hydraulic, the environmental protection and handling of drainage need to bring the difficulty of the larger field implementation.

II. THE GROUNDWATER ADVERSE IMPACTS ON THE WHARF

Adverse impacts on the wharf ground water is soak in for a long time Groundwater in the soil will soften or mud, and soil parameter c and ϕ value will decrease, and the underwater soil under the function of buoyancy, the effective stress will decrease, thus makes the bearing capacity of the soil and anti-sliding ability reduce at the same time. Second when the steep fall in the water, yards Head wall of backfill soil permeability coefficient is small, the discharge of groundwater is Slow, and there is friction between soil particles, the pore of groundwater flow impeded, the underground water level drop behind the water level, in the block Cause the head between front and back of the wall Δhw . to impact By the head Δhw , additional ground water pressure w_0 on retaining wall is bound to be adverse settlement and groundwater pressure w_0 increased the instability of the retaining wall horizontal thrust[1]. With the increase of the head at the same time the hydraulic gradient of the seepage field also increases, when the water pressure is greater than the resistance between the soil particles after groundwater

Soil will begin to flow, the flow process of the dynamic water pressure is produced

Force, increase soil slip power, and reduce the stability of the wharf safety performance.

III. THE RESEARCH STATUS AT HOME AND ABROAD

Groundwater has been a factor in the geotechnical engineering cannot be neglected. Especially in the foundation pit engineering, Many kinds of damage caused by groundwater seepage as well as the well-up water enormous influence on the construction, related to the groundwater seepage, rainfall, and drainage work becomes very important. At home and abroad have done a lot of theory of groundwater seepage related research, numerical simulation and practice work, etc. Combined with the practice of foundation pit excavation of seepage control, the study of dewatering and drainage method, and summarizes the also many. Previous focus on the microscopic mechanism of seepage and seepage research and theoretical calculation, when faced with complex geological structure and diversity of the practical problems in applications of hydraulic recharge boundary, these theoretical calculation will encounter many difficulties in reality. At the same time, in the foundation pit engineering seepage control, dewatering and drainage

method choice, In addition to consider engineering validity of the method itself, also consider engineering economic benefit between different methods, this is to choose a engineering method on the basis of put forward higher requirements. Throughout most of the existing research at home and abroad, of coastal landforms sand & limestone double hydrogeological conditions of seepage control of large foundation pit excavation, dewatering and drainage engineering practice project number and depth is limited, in recent years, research and application has some similar, the following classification description.

A. The calculating method of hydrogeological parameters

Large foundation pit during construction period, the hydrogeological parameters of calculating is an important work, the accuracy of the hydrogeological parameters directly determine the foundation seepage control, rainfall, drainage and other aspects of accuracy, reliability and security. Reasonable selection of the hydrological parameters at home and abroad a wide range of research. Sum up, the study of hydrogeological parameters there are two main methods[2]. Method 1, use interior model, combined with darcy's rule for permeability coefficient value; Method 2, in the field of pumping test, water seepage test, water injection test, the water pressure test, according to the test results, using analytical method, numerical analysis method of inversion of hydrogeological parameters.

B. Mechanism of fractured rock mass seepage field and the cut-off for its effects

Broken rock mass is a kind of common geotechnical engineering loose deformable porous media, seepage characteristic of loose and broken rock has obvious, seepage not only affects the physics characteristic of rock mass, rock mass stress field of rock mass has important influence[3]. Groundwater seepage has a great influence on rock area project, include at least the following three aspects:

① Groundwater can lead to the decrease of strength of rock mass, groundwater increases the risk of engineering accidents;

② The groundwater can destroy many engineering construction need of dry construction surface;

③ For the aspects such as to ensure surface dry construction and engineering security of seepage control, dewatering and drainage measures can bring adverse effect to the surrounding environment. At present, people have to have done a lot of soil seepage and extensive research, and has made remarkable achievements. But, in contrast, the percolation mechanism of fractured rock mass is still inadequate, and due to the inhomogeneity, anisotropy of rock fracture, makes rock mass seepage mechanism of percolation mechanism has obvious difference with the soil. Study the percolation mechanism of fractured rock mass is of important theoretical value and significant social benefits.

With the rapid development of computer numerical calculation, numerical simulation become the main method of the fractured rock mass seepage calculation. Groundwater seepage on the slope, foundation pit, the influence of dam foundation engineering has got people's full knowledge. Compared in terms of increased stability, mechanical reinforcement measures, people are more likely to set cut-off, waterproof curtain, such as seepage control structure, and adopt measures to drainage decompression. In recent decades, research on groundwater seepage has larger development, the research results show that setting cut-off the amount of water seepage decreased significantly after excavation, to

stop water heavy curtain head drop deep influence is obvious.

Although the studies for the engineering application has brought the important theoretical guidance, but the depth and breadth of all can't meet the engineering application. Cutoff wall, on the other hand, most of them are study of groundwater seepage in soil (uniform, continuous media), while for the impervious structure of rock mass under (inhomogeneous and discontinuous medium) fracture seepage field has certain reference value, but the difference is very obvious.

At present, the cut-off wall and waterproof curtain seepage prevention structure of all kinds of parameters, such as, effect, influence range is generally rely on the experience of the engineers, such as the lack of scientific, also increased the construction risk of accident. The need for seepage control structure of the rock fracture seepage field research.

C. Well point precipitation

Well point dewatering generally fall into the light well point precipitation (single or multi-layer), injection well point precipitation, pits and deep well point precipitation well point precipitation. Its research direction mainly divided into the hydrogeological parameter and well point design from two aspects[4].

Design method of well point dewatering confined to the foundation pit engineering, as a means of drainage, the general design on the basis of pumping test in determining hydrogeological parameters, in accordance with the corresponding formula to solve the total yield in foundation pit drainage, caliper, well spacing and single well water output, etc.

D. Environmental impact assessment of large foundation pit drainage

As people increasing environmental protection consciousness, environmental protection is to become an important link in the process of project. Stability of foundation pit engineering in addition to meet their own requirements, also need to meet the requirements of surrounding environment protection[5]. Has long been more focused on the environmental impacts of foundation pit engineering of supporting structure, rainfall and excavation construction activities caused by adjacent land subsidence and uplift, causing a further deformation and cracking of adjacent buildings and underground pipelines, etc. And for a large foundation pit effluent water impact on the surrounding natural environment and ecological balance is very limited research; Groundwater water quality within the scope of the original foundation pit (suspended solids content and chemical composition and concentration, etc.) and the surrounding rivers or the sea water quality will have certain difference, the difference to the environment and the way of ecological impact, influence and solution of the research has important practical significance.

E. The defects of the existing research

To sum up, the previous foundation seepage prevention research focuses on the study of microscopic percolation mechanism and the seepage control method, the research method also is more theoretical derivation and numerical simulation, and as the research object of foundation pit engineering is mostly smaller. As the foundation pit scale bigness, of complicated hydrogeological condition, the design scheme for draining the precision higher requirements are put forward. Therefore, for complex geological structure and various hydraulic recharge boundary conditions of large deep foundation pit seepage control engineering how to choose integrated water and precipitation scheme to realize the optimal combination of technology and economy, solve a lot of outside water to the surrounding

natural environment and ecological balance is the study of the influence of the difficulty and innovation, research results for future similar projects also have important reference and guiding significance.

IV. THE MAIN CONTENT OF THE PROJECT RESEARCH AND DEVELOPMENT, AND TECHNICAL AND ECONOMIC INDICATORS

① Sand & limestone double-layered foundation of hydrogeological parameters acquisition and distribution characteristics

Pumping test results contrast analysis, in combination with water, precipitation and the entire water level monitoring in the process of excavation and formation core sampling, research on different hydraulic sand layer under the condition of boundary and supplies & limestone hydrogeological parameters of double-layered foundation and its distribution characteristics in three dimensions, and research in such geological area hydrogeology parameters survey of rational thought and method.

② Cut-off in the complicated hydrogeological conditions of water stop characteristics research[5]

Through the comparative analysis to the actual measured data and in combination with theoretical calculation and numerical simulation analysis, the comprehensive research in coastal landscape of sand layer of cut-off wall & limestone double check water characteristics of hydrogeological conditions, mainly include the following aspects:

- a) Study of diaphragm wall in different depths of water stop into the rock characteristic and effect;
- b) The cut-off from excavation area water characteristics and effect of different distance;
- c) Research in groundwater cut-off wall under different intensity of supply water characteristics and effect;
- d) The diaphragm wall and other measures for precipitation comprehensive check, rainfall characteristics and effect.

③ The design of deep well precipitation and its optimization

Effect analysis with the engineering practice and in combination with theoretical calculation and numerical simulation analysis, the comprehensive study of deep well under different hydraulic boundary conditions (land or sea side, is there a cut-off and different conditions such as of the cut-off distance) features and the key factors affecting the still water of (borehole diameter, spacing and depth, etc.); Comparative study deep well scheme combined with Ming other precipitation measures such as comprehensive precipitation for the different influence to the excavation effect; Study the effect of deep well in such geomorphic geological conditions radius and the group of the well effect; Research under the condition of deep well in such geomorphic geological structure features fabric (caliper, thickness, etc.) and their effects on reducing discharge of suspended solids in water content.

④ Drainage environmental issues

Through to the goal of drainage area water environment and ecological environment of the real-time monitoring, and combined with 3d numerical simulation analysis, the research on different drainage intensity and concentration of the chemical conditions, the target of drainage area water environment and the influence of the

ecological environment and the harm degree, simulation, analysis and evaluation, find out the solution[6].

V. THE APPLICATION PROSPECT AND THE FORECAST OF ECONOMIC BENEFIT

Along with the increase of excavation engineering all over the world, draining engineering application is more and more widely, in the similar to the project of large foundation pit engineering draining engineering has a pivotal role, will have the greater development in the future construction applications. As domestic enterprises to undertake overseas foundation pit project quantity and the increase of the scale and the globalization trend of the engineering area location, late prophase engineering hydrogeology survey and draining scheme design in the construction of foundation pit excavation project has great practical significance. Because of the complexity of the hydrogeological conditions, further studies the applicability of the drainage scheme and precision will be the needs of the development of engineering, offer valuable reference for all kinds of large dry excavation engineering. At present Chinese enterprises in southeast Asia, the Middle East and Africa and other developing countries overseas develop foreign markets, in the port, waterway and other large-scale engineering is the area national strategic development needs, is expected to have a lot of similar projects in the region into the line construction, so the large type of foundation pit drainage technology in obtains the good economic and technical benefits at the same time, also for future overseas market development has a huge role in promoting.

Drop drainage can be a variety of comprehensive utilization of precipitation method, using water in the process of excavation, rainfall measures to achieve the purpose of dry excavation; Through the study of engineering hydrology, and use a variety of draining method to carry on the comparison, thus reasonable to adopt a variety of comprehensive utilization of precipitation method can not only save costs, and can shorten the construction period, at the same time protect the environment effectively, in the dry construction of foundation pit engineering to achieve the objective of the economy, efficiency and environmental protection, the project to produce good social economic and environmental benefits.

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The Design Of Multi-Campus Low-Value Consumables Management System Based on J2ee

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Abstract—Traditional consumables management style has been unable to meet the development of colleges and universities which have multi-campus. The article uses workflow idea to de-sign the function and architecture of a consumables management system which based on network in details, and uses J2EE framework developing the project. The system has good scalability, high security. And it can manage the universities' consumables timely, transparently, dynamically.

Index Terms— multi campus, consumable, management system, workflow

I. CONSUMABLES MANAGEMENT STATUS AND SIGNIFICANCE

Low-value consumables belong to the items which is easy to consuming in use, and price below the standards of fixed assets. Fixed assets, the useful life are more than one year, consist of the special equipment which priced at more than \$ 800, and the general equipment which priced at \$ 500 or more, also can be kept the original forms in use. Consumables are the items that under the fixed asset's standards but beyond the range of materials.

A. Consumables management status

Due to low price and easy procurement chain, Low-value consumables become weak in institutional asset management. And the large number of low-value consumables, the high total price, enormous wastage of consumption, lead a big dilemma to the management. There are some problems in the management of the consumables, the following issues are serious:

First, university laboratory materials management has not enough emphasis on consumables management. Low-value consumables is different from the state-owned fixed assets, generally relatively lower value, varieties, large quantity, and upstream authorities not focused on. Therefore, consumables management is relatively loosen.

Second, consumables procurement procedures are not open, transparent. Many colleges and universities' procurement of consumables lack appropriate systems and procedures, and managed confusedly, each department purchased consumables by itself. Although some departments are centralized procurement, consumables are varieties, large quantity and complexity, the centralized procurement is only a mere formality.

Third, coordination and communication are lacked of among various functional departments. The Financial department is responsible for the assets' accounting, other departments manage material objects. The leaders, asset managers, user departments are lack of understanding of the amount and distribution of consumables. They neither make an inventory of stock across sectors termly, nor have a coordination and communication.

Finally, universities and colleges lack of scientific management methods. Low-cost consumables are largely manual registration and based on the stand-alone system. This not only make the management staff tired, but also

cause a certain degree of difficulty to the management, and is not conducive to the management of open, transparent, and information technology. And many colleges and universities have multiple campuses, which lead to the difficulty of information exchange between the campuses, bring inconvenience to the management of consumables.

B. Significance of consumables information management

In recent years, due to the college has been extended and continue to establish new campus, expand the size of the campus network, and informational office is increasingly common, manual management of consumables and stand-alone management system has become increasingly unable to meet the school's development, and then consumables management system online is on the agenda. WEB-based multi-campus consumables management system using network technology and database technology can achieve the following objectives:

The management is information technology. We established low-cost consumables database that various departments of the school can use to inquiry, register, counting information and so on through the client. The system realized the management of the whole school's consumables departments, and improved the management efficiency and accuracy.

The management has office network. Web-based information management of low-value consumables, breaks through the restrictions of time and space, especially for multi-campus college, and can strengthen the campus's contact, achieve a fast and efficient management.

The consumables management is open and transparent. We can oversight the procurement process, procurement examine and approve progress, bidding information, statistical information, and using status to realize information publicity.

The management can scientifically make policy. Through information comprehensive statistical analysis, it is possible to detect problems in the low-value consumables procurement, and then adjust timely, give the reference to the leadership for decision-making, and facilitate the flexible deployment of item at the same time.

II. CONSUMABLES MANAGEMENT STATUS AND SIGNIFICANCE

Low-cost consumables management system uses multi-layer structures, so that it can extend and maintain the system. Due to using the B/S mode, the client can be a personal computer connected to the Internet, laptop or mobile phone, remote users only need browser. This system provides some data message of low-cost consumables management system, so that users can declare, approve, control and register, and so on. And users do not need additional settings and to install any other software.

Server-side software, Apache Tomcat, MySQL Server, and the server-side Control Class, read and analysis the

data that remote user's browser send over through the Internet , call the appropriate components to complete the business logic, and returns the results and visual data to the client and displayed on the browser.

III. SYSTEM DESIGN

The low cost consumables network management is a direct impact on the level of laboratory management, and the quality of teaching personnel training. To this end, the development of functional laboratory low cost consumables NMS is very necessary.

A. Functional Design

The overall function of the system was mainly for information publicity, reporting, approval, board system statistics and management. The system used workflow patterns, submitted by the reporting staff, approves by the approval personnel, and then registers procurement information after approval. There are also user login, change password, administrator add and view users at all levels and give permission. The overall workflow is shown in Figure 1.

Based on the analysis of demand, this system provide administrator, reporting user, approving user, procurement center manager, and the various types of users have their own functional competence.

The system has six functions.

- Information publicity module

In this module, administrator decides how public the information is, and opens different information to different users, including purchasing information, item usage tender information and other ancillary information.

- Reporting function

The reporting staff has a reporting function, the reporting staff of each department log on to the system, fill requisitions according to need, and click the button to submit.

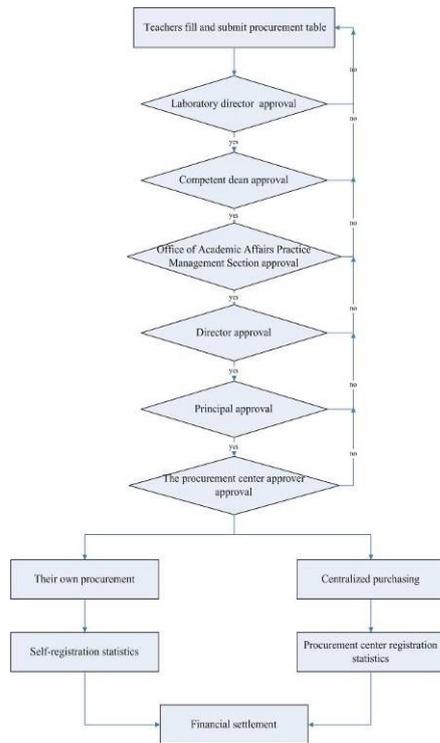


Figure1. System work flowchart.

- Approval function

The approval function is the core functionality of the system, approving officer has the function. Based on the approval process, purchase orders submitted by the reporting officer enter an approval process for approval. If approval is not passed, then the purchase order will be turn back to the reporting staff, and if the order is approved, and then it will enter the next phase for the approval. The approval function of this system, has achieved the public service automated, extricated from the paper approval era and the stand-alone approval, saving the approval turnaround time. No matter where you live and when it is, as long as you can contact to the Internet, you can view and handle the approval information. Also this function saved resources, time and effort, realized information and dynamic management, and laid the foundation for the smooth progress of the university teaching and research.

The innovation of approval part is that it uses the idea of workflow. The workflow is a calculation model of the work processing, the logic and rules how the work of the workflow be organized, and then represented and calculated in the computer to an appropriate model. Traditional approval, using paper forms and manual transmission, has a low efficiency and can't achieve statistical reporting capabilities. However, based on this workflow system, the users only need to fill the form in the computer. And the form run down automatically in accordance with the defined processes, the next level approver will receive the relevant information, and modify, tracking, management, query, statistics, printing and so on. Thus, the system greatly improved the efficiency of information management, enhance the school's teaching and management efficiency. Also, administrators can also set required approval levels, and levels of approval, and approval range dynamically. For example, the laboratory director of the Institute of Modern Educational Technology of the Instructional colleges can only view the reporting form of their own laboratory, but the dean can view the reporting form of all laboratory.

- Registration and statistical functions

Registration and statistical functions, after the entire approval passed, centralized procurement purchasing by the procurement centers or the reporting officers themselves, and then registered.

- Procurement statistics

Procurement center is responsible for procurement statistics, including purchase amount statistics, consumables usage statistics, summarize printing of each academic year. Using computer to do amount summery directly can avoid the artificial statistical errors, and improve the correct rate, saving manpower and resources

- Administrative functions

The administrator has administrative functions to add and delete users at all levels, and to allocate rights to all levels of user, to add and delete faculties or laboratories, to determine the degree of information publicity and so on.

B. Security considerations

Users' login password used MD5 encryption. MD5 is widely used for login authentication when the user logs in. It used MD5 Hash to calculate the password user input, compared the MD5 stored in the file system, and then determines whether the password entered is correct. So you can determine the legality of the user login. SSL digital certificates can be used for system users, including administrators, to ensure data security.

Administrators need landing two times, the first landing is the user, and the second landing enters the

background management. You should make the user name and password different between the first time and the twice as far as possible, and then enhance the system's security. The administrator has the highest authority in the system user, so administrator login authentication security settings are very important. Administrator can consider using the IP address of the certification, can login and manage only on the specific host-specific address in the campus network.

IV. DEVELOPMENT OF LOW-VALUE CONSUMABLES NMS

A. System Architecture Design

According to the functional requirements and business needs, the system uses a five-layer structure of J2EE and B/S architecture, including the presentation layer, service layer, business logic layer, data persistence layer and data layer.

The system used Struts, Hibernate, Spring and other lightweight framework for technology development. Struts realized the separation of data reality and data invoke; Hibernate achieved the lasting operation of data; Spring managed a variety of services and dependencies. Database used SQL Server database technology, to facilitate the management of large amounts of data and to ensure data security.

This ensured that the system loosely coupled, low coupling, extensible. The system was able to provide services to other teaching management system in the form of services, and achieved system integration easily.

B. Program implementation

In the presentation layer, the system mainly uses Struts framework, JSP + Ajax technology. JavaScript code is embedded in the JSP page, to realize the basic check. The client application, interactive and real-time, is mainly used JavaScript to call XML HttpRequest object and submitted a request via XML asynchronous to the web server and get a response, to updated the page depending on the response, realized the page without refreshing. This is a comfortable experience.

In the service layer, the system develops a Web Service based on Axis. We can add the Axis Servlet configuration information to WEB-INF/web.xml file of the system, and generate the WSDL document publishing service, released service through the ServiceMix tool agent service, which is easy to discover and invoke services.

In the business logic layer, it uses JavaBean to realize business logic of the system and called for the service layer.

In the data persistence layer, the system uses the Hibernate, lightweight framework, to solve the problem of OR mapping, build a data persistence layer, configure

the connection pool. This can reduce the coupling of the system, expand the system functions easily, and ensure a relatively stable business logic layer.

In the data layer, the system uses SQL Server2008 database to achieve the physical implementation of the data. Using stored procedures to access data information, can optimize the performance of SQL Server, simplify the programming of the system, hide the system's internal implementation details, and improve the simplicity and flexibility of the system.

V. SUMMARY

J2EE-based low cost consumables management system changed the original stand-alone management, paper management model, and realized school consumables management information technology, networking and automated, achieved consumables administration efficient, safe and clean.

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Procedure Standardization and Result Efficiency: the Method to Deal With the Ethnic Affairs

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Abstract—Ethnic affairs concern national unity, border stability, economic development, but also social harmony. Since the foundation of People's Republic of China, the successive leaders of Chinese Communist Party attach great importance to ethnic affairs. According to the national theory of Marxist, leaders of Chinese Communist Party focus on practical issues in the ethnic issue, summarize the experience of solving ethnic affairs, thus creating a road with Chinese characteristics to deal with the ethnic affairs. This passage tries to analyze the successful experience of CCP dealing with the ethnic affairs in two aspects: the first one is procedure standardization. Under the guidance of Constitution of PRC and the Regional Ethnic Autonomy Law, the procedure of dealing with the ethnic affairs is legitimate and standardization. The second is result efficiency. When dealing with the ethnic affairs, stability is concerned, and at the meantime, we also pursue the economic and social development of ethnic minority areas.

Index Terms— Chinese Community Party; Procedure standardization; result efficiency

I. INTRODUCTION

We Chinese people all have the wish that we could realize the great rejuvenation of Chinese nation. However, some disputes have aroused when the concept of Chinese nation put into use of dealing with the ethnic affairs. Some people hold the opinion that for national unity and equality, it is a must that to eliminate national differences as soon as possible, creating a Chinese nation with high similarities. While, this opinion may lead to an excessive and overheating ethnic policy. Another opinion shows that Chinese nation is a whole name, and it stresses assertive minority ethnicity, but it also may easily weaken the minority ethnic identity and national identity to the Chinese nation. Seeing from the Chinese Communist Party's successful experience in dealing with the ethnic affairs, it is necessary to create the concept of Chinese nation, but superficially put all the nations together is meaningless. Only to face the differences of different nations in reality, to take development as the core, and to avoid big-nation chauvinism and local nationalism doctrine, can the equality, unity and prosperity of the whole Chinese nation be truly fulfilled.

"Nation-state is a basic national form since modern times, and it is also a basic unit of the world's system." 1 Ethnic affair is a worldwide problem; the Chinese Community Party has creatively found a method to deal with the ethnic affairs in practice, and it sets a good example for the rest nations of the world. The key of China to achieve effective and initial success in dealing with the ethnic affairs is procedure standardization and

result efficiency. This passage start with the question that "what is ethnic affair", and then the basic principles of handling the ethnic affairs, the basic system and the basic strategy this three points to explain the role of procedure standardization and result efficiency play.

II. CLEARING THE ESSENCE OF ETHNIC AFFAIRS: THE PREMISE OF HANDLING THE ETHNIC AFFAIRS PROPERLY

It is a fact that ethnic affairs are very complex, therefore, the first step to dealing with the ethnic affairs is the make clear the essence of this problem, which also provides a criteria for the effectiveness of handling the ethnic affairs. As for the definition of the essences of ethnic affair, there were some mistakes in the history, which do great damage to the work of ethnic affairs. However, since form the reform and opening-up policy has been carried out, the CCP and the government has cleared the essence of ethnic affairs, providing the basis of dealing relative problems. At the beginning of founding the PRC, the CCP has taken ethnic equality, ethnic unity, ethnic regional autonomy and common prosperity of all ethnic groups as the core of framework of ethnic theory policy.² According to this theory, the CCP successfully united all ethnic groups into the socialistic revolution. Until the beginning of the 1960s, in the influence of the erroneous theory that "class struggle is the core", the essence of ethnic problem is taken to be as the class problem. Many minority elites become the sufferers in the class struggle; their criticism and opinions through the proper channels of government proposed to be known "counterrevolutionary letter", "offensive to the party". While those persecution to the elites was seen as the product of "class harmony".³

With the second generation of central collective leadership whose core was Deng Xiaoping, the wrong definition of ethnic problem has been corrected, and the focus of ethnic affairs has been shifted from class struggle to economic and social development. In April 1980, the CPC Central Committee approved the "Tibet Work Forum Minutes", and put forward that the substance of our ethnic affair is not a class issue, but rather the relationship between working people. At the same year of 15 July, People's Daily issued an article to further explained the ethnic problem: the root of the ethnic problem in socialist period is the inter-ethnic differences and ethnic inequalities in fact. This assertion provide a direction of dealing with ethnic affairs, making the minority's economic development in order to eliminate facto inequalities become the central task of the national work.

Since then, the essence and focus of ethnic problem have been cleared, our country's ethnic problem worked out successfully as a whole; and at the meantime, the CCP and national leaders keep pace with the times, putting forward some supplements of dealing with ethnic

affairs better. The third generation collective leadership with Jiang Zemin as the core put forward that the core of ethnic problem at this stage is to accelerate the development. In order to accelerate the economic development of the minorities, the State Ethnic Affairs Commission launched the initiative "Frontier Action", developed the west regions, and carried out poverty alleviation campaign. Some of these policies continue to this day, which play a significant role in accelerating the development of ethnic minority areas, reducing economic inequalities of all ethnic groups and so on. For the goal of building a moderately prosperous society, the central collective leadership with Hu Jintao as the Secretary General has put forward some policies for better development. All ethnic groups, "working together for common prosperity and development" have become a theme in the new times. September 2014 saw Central Ethnic Work Conference was convened; the general secretary Xi Jinping delivered an important speech, saying that we should let all the ethnic groups enhance the recognition of our mother land, the Chinese nation's identity, Chinese culture, the socialist road with Chinese characteristics.⁴ We should strengthen national unity, and pay more attention to Chinese cultural identity.

III. PRINCIPLE AND PRACTICE COMBINED: ETHNIC EQUALITY, SOLIDARITY AND COMMON PROSPERITY

Ethnic equality, solidarity and common prosperity are the combination of principle and practice. According to the theory of ethnic equality, since from 1950s, it took more than 10 years to identify the ethnic groups, and those who suffered a lot because of their minority identification finally regain their identity. All ethnic groups are equal, and there is also no distinction or distinction of different ethnic cultures. The CCP and the government always respect the customs of ethnic minorities, and propose many documents, such as Indication for handling those appellation, place name, stele and plaque which are discriminatory or insulting minority nature, Some notes on cattle operations related to the customs of Hui people and so on, for the procedure of standardization of ethnic affairs work. On unification of national holidays has made provisions for minorities' name, diet, festivals, marriage, funeral, apparel and other customs. Those complicated and detailed documents are the protection of result efficiency.

In 1981 the idea of "Two important factors" emerged in the Summary of Discussing Affairs in Xinjiang of the Secretariat of Central Committee, but at the investigation in Xinjiang, Jiang zemin deepened and improved the idea as "Three important factors". In the Selected Works of Jiang Ze-Min, the issues about uniting minority and preserving national unity were repeatedly for many times and he also emphasized the importance of the ethnic unity in Xinjiang remote district. In the visitation to Tibet, he addressed a special speech to anti-secessionism. And on the 3rd forum of the CCCPC and the State Council about affairs in Tibet, he put forward the working policy of grasping two key links of stability and development at the same time. ⁵In May 2005, the CCCPC and the State Council convened the 3rd Central Working Conference about Nationality Affairs where Hu Jintao explained the connotation and relationship of "Two Common". ⁶ National equality, unity and mutual assistance and common prosperity deepened their

theories, having promoted repeatedly and successfully by several generations of leaders of the CCP.

IV. EFFICIENCY AND LEGALIZATION: TWO PILLARS OF THE SYSTEM OF REGIONAL NATIONAL AUTONOMY

The implementation of the system of regional national autonomy is under the guidance of corresponding laws and regulations, and which is the inevitable requirement of procedure standardization.

On May 1, 1947, the first ethnic minority in our country ---- The Inner Mongolia Autonomous Region was established, which marked the beginning of the regional national autonomy policy in overall implementation. Then the Common Programme constituted by Political Consultative Conference established the system of regional national autonomy as the basic political system. The absence of specific regulations, which was replaced by principal stipulations in the Common Programme, caused the appearance of lacking standardization and disunity in the methods, which every region used to deal with their affairs.⁷ In 1952, the Regional National Autonomous implementation Program of The People's Republic of China was promulgated and implemented. It gave the system of regional national autonomy more comprehensive provisions, after borrowing the successful experiences of the Inner Mongolia Autonomous Region and summarizing the practical experiences since the New Democratic Revolution. With the guidance of this document, the autonomous regions were gradually established and the system of regional national autonomy was extended to the whole country. Result efficiency has requirements on the correlative law provisions of the regional national autonomy system as well as on effectiveness of law. The Constitution of PRC amended in 1982 made some amendments and compensations in dealing with ethnic affairs. And the new situations and problems we faced in new stage proposed the urgent need to the laws and regulations of regional national autonomy. Therefore, in 1984 the National People's Congress approved the Regional Ethnic Autonomy Law, after having learned from both of the positive and negative experiences more than three decades, which played a significant role in theory and practice. The system of regional national autonomy from its promulgation have advanced with time, constantly improved its legal system and provided legal support for the implementation of regional national autonomy system in real life. And the Chinese Communist Party values that the amendment of regional national autonomy law could keep pace with time very much. As Li Peng, who was the chairman of the Ninth National People's Congress Standing Committee said: "some articles of regional national autonomy system are out-day after having been implemented for nearly more than two decades, with dramatic changes of social situations, and the new born problems in the new stage of social development require the new articles of law. ⁸ Despite the correlative law provisions, the effectiveness of regional national autonomy system's implementation also have to pay attention to the nourishing our cadres of ethnic minority, as they are the main factors whether the regional national autonomy makes sense or not.

V. SERIOUS CONSIDERATION AND STABLE ADVANCE: THE FUNDAMENTAL STRATEGY DEALING WITH ETHNIC AFFAIRS

Ethnic affair is a long-term issue whose essence is about the development issue in every region, which is the fact that the national distinction caused by all ethnic inequalities in reality, has difficulty in disappearing under current less-developed productive forces. Therefore this fact we face makes the serious consideration and stable advance fundamental strategy of result efficacy.

After new China was founded, the CCP focuses on the actual situation of every ethnic, and receives a great achievement in land reform, ethnic and religious issue having taken the working guideline of serious consideration and stable advance. In 1950, Mao Zedong, who was the chairman of China, in the Third Plenary of the 7th Central Committee of the Communist Party of China said: "the social reform of ethnic minority areas is a important thing and need serious treatment."⁹ And in October, Zhou Enlai who was the Prime Minister of China pointed out publicly for the first time: the internal reforms of every ethnic area must take the guideline of serious consideration and stable advance, in accordance with the understanding and will of majority in ethnic minority area."

During the land reform, Yun Nan province established relative reform program for 4 different reform districts named "Dam District" "Buffer District" "Peaceful Reform District" "Direct Qualified District" divided according to different situations. Because before the socialist transformation all ethnic minority areas had different social nature, the Central Committee of the CPC used different targeted solutions, having guaranteed the social stability. Serious consideration and stable advance this strategy is the crux of the Tibet's successful reform. After the peaceful liberation of Tibet in 1951, the endeavor to gain the support of the superiority in the area should replace the drastic reform. Five years later, the Autonomous Preparatory Committee of Tibet was set up, which existed with the Ga Xia government and Conference Hall of Ban Tankan, and promoted the reform sable and peaceful. Although 3 years later the reactions launched rebels against the CCCPC, taking actions against rebels while promoting reforms, who firstly united the advanced superiority, and established the county and town governments through polls which made people took part in the elections. And as the socialist transformation finished gradually, the Tibet Autonomous Region was established. Our country insists on the guideline of serious consideration and stable advance, especially in religious issue. It is a common phenomenon that the ethnic minority in China have faith in religions, even extending to all people in ethnic minority believing religions. When the religious issue mixed with the ethnic affairs, the difficulty appears. Therefore the CCP the government took the reform of the Islam and Buddhism serious. They held a symposium of CCP at first to make sure the basic guideline, and then put forward different policies to different areas according to their specific situations in order to make the reform advanced carefully and stably.

VI. CONCLUSION

The fact that the essence of ethnic affairs is about the ethnic development provided evaluation standard for the result efficacy; the organic integration of the principle of ethnic equality, unity and common prosperity and the practical experience of ethnic affair is the same

relationship of the procedure standardization and the result efficacy; The two pillars of regional national autonomy system are just the systematics and effectiveness, and the serous consideration and the stable advance are the inevitable requirement dealing with ethnic affairs. On one hand, the ethnic affair's standardization demanded setting up correlative law, regulation, rule and method, based on the Constitutions of China and the Regional Autonomous Law, in order to improve the fundamental theory, principle, basic system and basic policy; on the other hand, the work pursues for the result efficacy, and while handling the ethnic affairs, we ought to follow the aim of social stability and development, to achieve the goal of Chinese nation's great revival. The procedure standardization and result efficacy partially displayed the success of the CCP in solving ethnic affairs, and the fact that the action we stick to these two principles contributed to the development of ethnic affairs.

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The Research on Parallel Driving Models by Analysis To Cognition and Behavior of Users

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Abstract—Mankind is capable of cognizing and handling multiple tasks at the same time. Driving is the task in which the continual combination and alternation of various basic tasks is involved. And, a number of the foresaid basic tasks need to be handled and completed simultaneously; therefore, the research looking into the parallel behavior of drivers is needed. Parallel driving has the attributes, relevance and exclusiveness, that leads to different representations according to various danger classes. In this article, the parallel driving model is put forward, and an experiment is developed to test the performance of the drivers. Through the experiments, validity of the model is verified.

Index Terms— parallel behavior model, drive, cognitive

I. INTRODUCTION

In the field of cognitive science, cognition of mankind is assimilated to the processing of computers. In the procedure, human brain plays the role of central processing unit (CPU). In the case of computers, these machines can not only deal with different problems in single-threaded way but also perform multiple tasks simultaneously in a parallel way. The latter situation of handling several problems at the same time is named as multiple tasking[1]. Human cognition, as a highly complex systematic function, faces tasks that involve massive information processing for most of the time. Driving is the continual combination and alternation of basic tasks, some of which take place in sequence while others occur simultaneously. The need of studying parallel driving behavior lies in the numerous parallel driving tasks exists in the behavior.

II. BEHAVIORAL MODEL FOR PARALLEL DRIVING MODEL

The parallel driving model is put forward based on the analysis of the characteristics the behavior and the way in which it is cognized and handled. And, the model is depicted in Fig. 1[2].

To test the effectiveness of parallel driving model, we have designed an experiment. The experiment is set in the scene that a pedestrian, crossing the road, without noticing the running car, appears suddenly before the car in right front direction[3]. On this occasion, the cognition and reaction of the drivers, based on the cognitive-behavioral parallel driving model, can be classified into three types referring to the association and exclusiveness of driving behavior.

i) The first one is the low-risk situation in which the drivers can make judgment calmly and perform operations in a single-threaded way, provided that the pedestrian is beyond safe distance.

ii) The second one is the medium-risk situation in which the drivers enter the state of arousal swiftly and make correct cognitive analysis, combined with appropriate multi-threaded operation of each task.

iii) The third situation is the high-risk situation, provided that the pedestrian is very close to the car, the driver, with subconscious module simulated, will react to the situation promptly and perform each action in a largest possible parallel way.

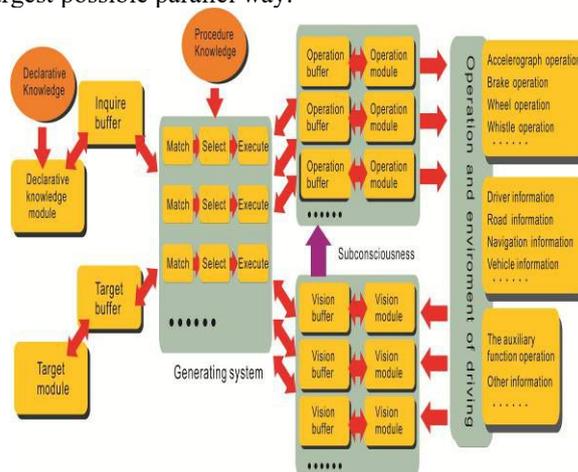


Fig. 1 Parallel driving behavior model

A. Contents of the experiment

i)The goal of the experiment

The objective of the experiment is to testify, with the use of experimental method and analysis of quantitative analyzing model, the effectiveness of behavioral model. At the same time, the experiment should also accord with the principle of cognitive-behavioral model.

ii)Processes and setting of the experiment

The experiment is set in the scene in which pedestrians, crossing the road, appear suddenly in front of the car, running at the speed of 40kmh, in three different distances to pose a contrast. In order to avoid the happening of accidents, a series of reactions, including recognition, decision-making and conduction, will be activated. What we will do is to analyze the experiment statistics mathematically. Firstly, predictions about the reactions and the time them takes, which are assumed to be under different situations, will be made. Secondly, we will take samples and perform the experiment. The final step is to make statistics analysis

of the data to compare with the predictions, which are made in the first step, to testify the validities of them.

iii)The participants of the experiment

In total, there will be 20 participants, 13 of whom are male while the other 7 are female, aged between 20 to 50 years old. In addition, the experience of driving is not needed[4].

Using the parallel driving model to predict the drivers' behavior, according to the analysis of the reactions and movements of the drivers under three driving conditions—low-risk situation, medium-risk situation and high-risk situation, which are classified in cognitive-behavioral model of parallel driving—the hierarchical conductions performed by the drivers are shown, in detail, in the following Table 1.

Table 1 Driver's hierarchical motion

| Operation | Description | Time(s) |
|---|--|----------------|
| Perception | Drivers perceive the warning message with sensory organs | T ₁ |
| Cognitive decision-making | Analysis and, then, decision is made through cognitive model | T ₂ |
| Positioning | A finger is moving to the position of car horn | T ₃ |
| Sounding the horn | Drivers sound the horn | T ₄ |
| Turning the steering wheel | Drivers turn the steering wheel to change the direction | T ₅ |
| Releasing the gas and treading on the brake | Drivers release the gas; then, the brake is treaded. | T ₆ |

We have come to the conclusion, based on the foresaid parallel cognitive-behavioral model of parallel driving, that the drivers will act in different ways under different situations. Under low-risk situation, the drivers behave and react in a single-threaded way; under medium-risk situation, multi-threaded behavioral patterns are activated; under high-risk situation, subconscious modules are aroused and the parallel behavioral model is simulated, in the largest scale, to face the issue. Therefore, the actions, ordered in time sequence, can be described, in detail, hierarchically in the following form[5].

The time it takes, for the driver, to react to the issue, under low-risk situation, in the single-threaded behavioral model equals T.

$$T = T_1 + T_2 + T_3 + T_4 + T_5 + T_6 \quad (1)$$

When it comes to medium-risk situation, the driver will spend T seconds reacting to the issue in multi-threaded behavioral model.

$$T = T_1 + T_2 + T_3 + T_4 / T_5 + T_6 \quad (2)$$

Table 2 the reaction time of driver in low-risk task performance

| Operation | Description | Time(s) |
|---|--|---------|
| Perception | Drivers perceive the warning message with sensory organs | 0.53 |
| Cognitive decision-making | Analysis and, then, decision is made through cognitive model | 0.58 |
| Positioning | A finger is moving to the position of car horn | 0.28 |
| Sounding the horn | Drivers sound the horn | 0.29 |
| Turning the steering wheel | Drivers turn the steering wheel to change the direction | 0.50 |
| Releasing the gas and treading on the brake | Drivers release the gas; then, the brake is treaded. | 0.32 |

Firstly, we can easily calculate the reaction time of a driver under low-risk situation according to the above table.

When it is of low level of danger, the time that is spent in reacting to the issue is showed as follows.

$$TD = T_1 + T_2 + T_3 + T_4 + T_5 + T_6 = 2.50(s) \quad (4)$$

Under medium-risk situation, operation no.4 and operation no.5 will take place simultaneously; therefore,

The last situation, the high-risk situation, takes the shortest time, represented by character T, to handle, with the use of subconscious module and multi-threaded behavioral model, the problem.

$$T = T_1 + T_2 + T_3 + T_4 / T_5 / T_6 \quad (3)$$

In this experiment, the distance between the pedestrian and the car is 40meters to reflect low-risk situation. When the pedestrian appears 20 meters in front of the car, it is under medium-risk situation. And, if the pedestrian is only 10 meters, at the beginning of the experiment, away from the car, then the situation is of high risk. To measure the exact time of each action, with the purpose of predicting the time for drivers to fulfill the task under the situations, ordered in hierarchy, we will perform the experiment, at first, under low-risk situation because the reactions of the driver under that situation follow the rule of single-threaded behavioral model. We then, after taking the experiment, use model to predict performance time of each actions under low-risk situation, and the result is shown in the following Table 2.

in the calculation, the operating time of process no.5, the operation that takes longer time to finish, will be taken as effective time.

The schedule performance, of the reaction to the incident, is calculated as below:

$$TZ = T_1 + T_2 + T_3 + T_4 / T_5 + T_6 = 2.21(s) \quad (5)$$

As we analyzed before, under high-risk situation, operation no.4, no.5 and no.6 will take place concurrently; in this case, the performance time for

operation no.5, still being the one that takes longest time to finish, will still be used as effective time.

The prediction for operation time for high-risk situation is shown below:

$$TG = T1 + T2 + T3 + T4 / T5 / T6 = 1.89(s) \tag{1}$$

The prediction we make, by comparing the data we get from the above calculation, is that the testee will react fastest to the issue under high-risk situation, taking only 1.89s to fulfill or the tasks, and he or she will take action in a slower speed, as 2.21s are used in reaction, when the risk level is medium while the performance take the longest time, 2.5s, to finish under low-risk situation.

III. SAMPLING EXPERIMENT

Table 3 Test of Homogeneity of Variances - operational time

| Levene Statistic | df1 | df2 | Sig. |
|------------------|-----|-----|------|
| .584 | 2 | 57 | .561 |

Table 4 ANOVA -operational time

| | Sum of Squares | df | Mean Square | F | Sig. |
|----------------|----------------|----|-------------|--------|------|
| Between Groups | 2.838 | 2 | 1.419 | 90.882 | .000 |
| Within Groups | .890 | 57 | .016 | | |
| Total | 3.727 | 59 | | | |

We come to the conclusion, through the One-Way ANOVA analysis, that these three sets mean values, of the original data, differs remarkably; in another word, the drivers perform in significantly differentiated ways, shown in the operation time that varies in a large scale, under given situations. And, the performance is of the lowest under the low-risk situation and is of the highest under high-risk situation while the performance is average under medium-risk situation. The conclusion is based on the result—TD is 2.3325s, TZ is 2.0360 and TG is 1.8010s—that $TG < TZ < TD$.

CONCLUSION

Parallel model is a conceptual model with its focus on the reaction and cognition of drivers facing with emergencies. It reflects how the drivers, in order to avoid the happening of accidents, will react, under different level of arousal, to the situation. Generally speaking, the drivers are very likely to make some mistakes when driving in reality. As the model is not able to evaluate

To testify the effectiveness of the above prediction, we will conduct a sampling experiment. In the experiment, 20 samples are each to carry out three tasks—include low-risk task, medium risk task and high-risk task—respectively. During the experiment, the researchers are supposed to control the beginning and ending of the experiment while, at the same time, record the whole process to gather data of operation time, which is spent in finishing the three different tasks, of each person. The performance time of the experiments is shown in symbols, TD, TZ and TG. Next, the statistics will be analyzed by the computer with the use of a soft ware called spass. Spass is used to analyze, with the use of One-Way ANOVA analytical examination, the data to testify if there are any remarkable differences, which exist in the performances of the drivers, under various situations. And, the result is shown in table3 and table4.

performances that are formed in the situations with mistakes, it should not be used in the situation with unpredictable factors.

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Durability of Prestressed Reinforced Concrete Bridge in Chloride Environment

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Abstract—This paper describes the prestressed reinforced concrete structure and proposes durability of prestressed reinforced concrete beam bridge. For prestressed reinforced concrete structures under chloride environment, it introduces chloride ion erosion model, and corrects chloride diffusion coefficient; describes the design theory and methods of concrete durability.

Index Terms—prestressed concrete, chloride, durability

I. INTRODUCTION

A. Prestressed reinforced concrete bridge

Concrete, for its wide applicability and low cost, becomes the current largest amount and indispensable artificial material. In order to overcome its weakness that easily cracking in tension, late 19th century, European engineers created imaginary prestressed concrete. So that it can offset part or even all of the tensile stress by the dead and mobile loads generated, delaying the cracking of concrete structures.

B. Background and significance of concrete bridges durability

In the traditional concept, people think reinforced concrete bridges particularly prestressed reinforced concrete bridge is the durable structure that is rarely repaired or even not be maintained, and in a certain thickness of the concrete cover, steel does not rust. Therefore, people have the high expectation on reinforced concrete structures' service life, while ignoring its durability. However, in recent years, the deteriorated situation of concrete bridge damaged presented people a huge warning, while ignoring the durability problem and durability problem's research being lagging behind, people had to paid a heavy price.

Most of the steel bar corrosion is the conundrum in concrete structure. Steel corrosion caused by many factors, in which the main factor is the penetration of chloride ions to blunt steel, resulting in steel corrosion, causing concrete cracking around.

There are thousands of kilometers of coastline in China. In these areas, the concrete bridge bear the normal operating load, also had to withstand erosion which be caused by natural environment, such as tide and sea wave. Coupled with our northern winter period, in order to ensure smooth flow of traffic, people often use inexpensive deicing salt to melt snow. Deicing salt and chloride ion immerse the concrete, accelerating steel bar corrosion, shortening the life of the bridge structure.



Bridge be eroded by sea diag1-1



Bridge be eroded by deicing salt diag1-2

C. Durability of prestressed concrete beam bridge

Prestressed concrete beam bridge has a unique durability. First, prestressed reinforcement sectional area is smaller and a long time in high stress state, being sensitive to stress corrosion and hydrogen embrittlement; second, there is widely not dense in Duct Grouting causing fatal problems, such as the cross-sectional area dropped, broken wires, severe stress losses. Prestressed concrete durability have sudden failure, so a greater harm. For example, Britain Ynys-Gwas bridge, because the prestressing grout is not dense, corrosion of prestressing tendons, the bridge suddenly collapsed. United States Connecticut Bissell Bridge, causing corrosion of the bridge, the prestressing tendons decreased safety, in use 35 years later to reconstruction.

II. CHLORIDE PRESTRESSED CONCRETE STRUCTURES

A. Erosion characteristics of chloride ions

Chloride ions erosion in concrete is a slow process, and is a rapid development process with respect to the reinforced concrete structure of 50 to 100 years of life in terms of design. Transmission mechanism of chloride penetration are mainly three kinds: diffusion, capillary absorption, penetration. Three kinds of "penetrate" method generally collective effect.

B. Chloride corrosion mechanism

Prestressing tendons corrosion mechanism is complicated, and great majority is non-uniform corrosion, and likely to cause the structure brittle fracture without any sign. The joint action of stress and corrosive environment, based on the two different coupling condition, occurs different types of corrosion damage. Depending on the corrosion mechanism difference, it can be divided into several forms of electrochemical corrosion, stress corrosion, chemical corrosion, and corrosion induced by other factors

C. Establishing chloride diffusion model

Although chlorine ions from surface intrusion is a very complicated process, complexed multifarious sports, from the surface to the centre, but diffusion can still be regarded as the most important means of transmission. According to a large number of test results, it showed that the chloride ion concentration can be considered as a linear diffusion process.

1. The basic model

Chlorine ion diffusion process can generally quote Fick's second law. The law contact with the diffusion concentration, diffusion coefficient and diffusion time together, directly reflected structural durability. In order to ensure its applicability and simplicity, the law made assumptions: pore in concrete distribute uniformly; chloride ion diffusion in concrete is one-dimensional. Fick's second law can be expressed as:

$$\frac{\partial C}{\partial t} = -D \frac{\partial^2 C}{\partial x^2} \quad (1)$$

eq: C—chloride ion concentration; x—diffusion depth; t—diffusion time.

Initial conditions: C(x,0)=0

Boundary conditions: C(0,t)=C_s

C(∞,t)=C₀

eq: C_s—concrete surface chloride ion concentration; C₀— concrete initial concentration of chlorine ions.

Then, eq (1) analytical solutions:

$$C(x, t) = C_0 + (C_s - C_0) \left[1 - \operatorname{erf} \left(\frac{x}{2\sqrt{Dt}} \right) \right] \quad (2)$$

eq: erf(z): error function, expression:

$$\operatorname{erf}(z) = \frac{2}{\sqrt{\pi}} \int_0^z \exp(-u^2) du \quad (3)$$

2. Amendments to chloride ion diffusion coefficient

As people gradually deeply understanding chloride diffusion, chloride ion diffusion coefficient is no longer considered to be a constant, but be influenced by various internal and external factors, constantly changing.

(1) Effect of time to consider amendments

Concrete chloride ion diffusion coefficient will change over time, usually with a power function of time to be described. Time-dependent relationship is:

$$D = D_0 \cdot \left(\frac{t_0}{t} \right)^m \quad (4)$$

Diffusion coefficient of t₀ time is D₀; m— age attenuation coefficient.

(2) Consider the impact of chloride ion binding capacity correction

Chlorine ions in the invasion process, will be incorporated parts of chloride ions by the concrete. Studies suggest that only free state chlorine ions will cause corrosion of steel, chlorine ions, being combined, are not involved in steel corrosion process. Fick's second law will be amended by Martin-Perez etc.:

$$\frac{\partial C_f}{\partial t} = \frac{\partial}{\partial t} \left[\frac{D}{1 + (1/W_c) \left(\frac{\partial C_b}{\partial C_f} \right)} \cdot \frac{\partial C_f}{\partial x} \right] \quad (5)$$

eq: W_c—concrete water volume ratio; $\frac{\partial C_b}{\partial C_f}$ — chloride ion binding capacity; ∂C_b —chloride content at x; ∂C_f — free chloride ion content at x.

III. DURABILITY DESIGN OF PRESTRESSED CONCRETE IN CHLORIDE ENVIRONMENT STRUCTURE

The durability design of prestressed concrete structure is based on the structural damage law to checking its ability to resist environmental effects in the design life, whether it is greater than the effect on the structure of the environment; it shall consist of two parts: the computing part and the requirements of structure.

A. Design and construction work life environment

China's unified standard for reliability design of building structures made of various types of building structures "design life", and divided into four categories; design life respectively are 5, 25, 50, 100 years; examples are temporary structures, easy replacement of structural members, ordinary houses and structures, monuments and especially important architectural structures.

Life structure is closely related to the work environment. The different level of importance of building requires different design service life, so you have to consider the structure's working environment.

B. Durability design chloride environment

1. Durability design content chloride environment

Durability design of prestressed concrete structures, with being considered complex factors, includes the choice of durable materials, structural durability of structural measures and crack control measures, structural durability of construction quality requirements, structural members' regular testing and maintenance phases of requirements in the use phase, durability limit state checking requirements.

The general expression of the durability limit state:

$$R(t) - S(t) = 0 \quad (6)$$

Resistance of prestressed structures is composed of prestressing tendons and non-prestressed tendons, R(t)=R_s(t)+R_p(t). Usually, prestressed tendons bear most of the load, and structural resistance depends on tendons corrosion. Owing to the possible stress corroding, structural resistance may decay to zero at any time, then suddenly damage. Therefore, the durability limit state of prestressed concrete structures, should be taken the time of the occurrence of corrosion of prestressing tendons, commonly called steel critical corrosion limit state.

2. Durability limit state design expression chloride environment

Chlorine ion diffusion process general quote Fick's second law, diffusion model and error function have listed.

When the chloride ion concentration reached a critical concentration, C_{cr} , on prestressed tendons surface, it began to rust, and structure reached durability limit state. Durability limit state equation for prestressed structure in chloride environment:

$$Z(t) = C_{cr} - C_0 - C(x, t) = 0 \quad (7)$$

Assume that the initial chloride concentration, C_0 , in concrete is 0, durability limit state design expression of prestressed concrete structure under chloride ion erosion:

$$\gamma_0 \cdot \gamma_{cl} \cdot C_s \left[1 - \operatorname{erf} \frac{c/r_d}{2\sqrt{\gamma_D \cdot D_0 \cdot t_0^m \cdot T_d^{1-m}}} \right] \leq C_{cr} / \gamma C_{cr} \quad (8)$$

eq: γ_0 —Structure importance factor; γ_{cl} —Chloride role durability design partial coefficients; γ_D —Chloride ion diffusion coefficient partial coefficient; γC_{cr} —The critical chloride concentration sub-factor.

For prestressed concrete structures, the variabilities of prestressed reinforced protective layer thickness and the critical chloride ion concentration are not great, taking temporarily $\gamma_0 = 1.1$, $\gamma C_{cr} = 1.05$; selected values about γ_{cl} and γ_D has become a key. Usually when a reliable indicator of a goal is certain, prestressed reinforced protective layer minimum thickness relates to environmental category, concrete water-cement ratio and other factors.

IV. CONCLUSION

China now are in the construction period of rapid development, facing higher requirements for the design life of the structure and more severe durability problems, especially the durability problems of prestressed concrete under chlorine ion environment, which should attract attention and focus. This paper analyzes the corrosion mechanism of chloride ions, made of steel corrosion is one of the key of structural durability. In this paper, according to the chloride ion

diffusion, establish Fick's second law model, and consider the time effect, the chloride ion binding capacity and other factors on chloride ion diffusion coefficient correction. By analyzing the different work environment and effects of different factors, based on the reliability design of concrete structure durability, deduced durability limit state design expression, to further improve the durability of the design theory.

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Ecological Protection and Renovation of Lilong

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Abstract— Lilong contains unique Shanghai culture. However, with increasing urbanization, lilong blocks have been changed and destroyed. How to protect and renovate Lilong more ecologically is a question worth thinking about. By summarizing the formation and characteristics of Lilong, this paper analyzes its underlying ecological problems and explores ecological protection and renovation strategies for Lilong.

Index Terms—Lilong; ecological; protection and renovation

Lilong (“里弄”) are commonly known as “街堂” (alleys) in Shanghai. In ancient China, “five households make a neighborhood and five neighborhoods make a community.” “弄” means a “small alley”. Now, in general understanding, Lilong refer to an urban living form with a quiet living environment, in which residents live in groups, houses are adjacent, major and minor Lilong are connected, with concentrated lanes, many shops along the street and discontinuous landscape.

I. FORMATION AND CHARACTERISTICS OF SHANGHAI LILONG

Formation Background of Lilong

Lilong is not unique in Shanghai, but a common residential type arising from some big cities in China over the last hundred years. It was developed on the basis of traditional residential buildings in China and influenced by western terrace-house and strip-type buildings, to meet social and life demands at that time. It has a certain tendency to commercialization. On a national scale, Shanghai is one of the big cities with the earliest and the most Lilong buildings. Till modern times, Shanghai Lilong takes on metropolis colors quickly. The changes of structure are deeper and more gigantic than any time in ancient Shanghai. A deluge of Chinese and foreign immigrants arrive after the opening of port and infuse a strong exotic feeling into the residential structure of Shanghai Lilong. Shanghai Lilong, with local clans as the main body, evolve into a mixed dwelling place for Chinese and foreign people and a community for immigrants from all directions.

Characteristics of Shanghai Lilong

From the perspective of layout, it is not hard to find that Shanghai Lilong have the following two characteristics:

A bag-type layout of major and minor Lilong: For common Lilong buildings in Shanghai, stores from all walks of life are built outside blocks. The buildings inside, however, stand back against the downtown. Major and minor Lilong adopt a bag-type end processing, form “丁”, “廿”, “丰”, “旧”, “串” and other types of pedestrian traffic and avoid interference from unnecessary crossing. Meanwhile, some favorable conditions are also provided to reduce noises, ensure the safety of pedestrians and children, compile doorplates and manage public security in the neighborhood, etc. (Figure 1)

Economical use of land and space: The overall arrangement of Shanghai old Lilong is characterized by high building density and an economical use of land. Usually, the depth of Lilong buildings is 12 to 15 meters or so. In plane layout, bedrooms, garrets are auxiliary rooms are arranged around atriums. Two atriums adjoin and form a larger building space.

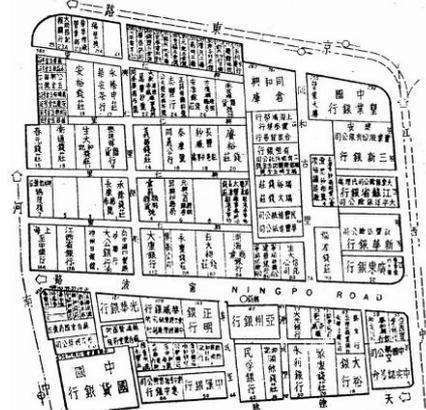


Figure 1: General Layout of a Private Bank Opened in Xingrenli before Liberation

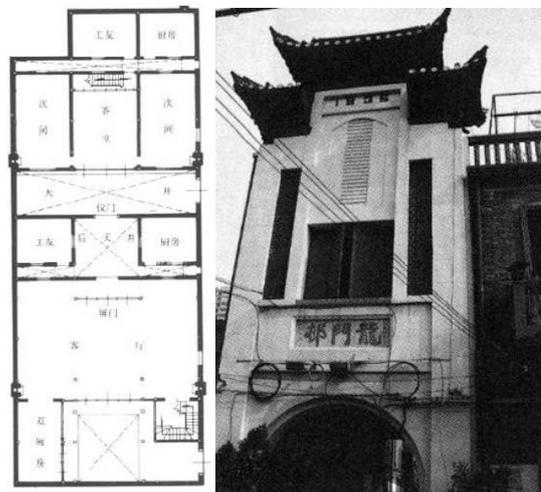


Figure 2: An Old-fashioned Lilong in Shikumen
 Figure 3: The South Elevation of Lilong

II. ECOLOGICAL PROBLEMS WITH MODERN LILONG

Shanghai Lilong buildings basically adopt a north-south orientation and pitched rooves. The plane layout is primarily a continuous form with small width and large depth (some have inner courts). This is to the advantage of the heat preservation and solar energy utilization of Lilong and also reduces the shape coefficient of buildings. However, there are also some ecological problems:

Large Depth Affects Lighting

The continuous plane layout of Shanghai Lilong, with small width and large depth (some have inner courts) causes “rear rooms” of Lilong (rooms between south rooms and garrets, facing rear atriums, with windows overlooking the north) to be dark. No natural lighting can be used, even in the day. (Figure 2)

Envelops Are Aged

A large number of Lilong are already or near “one-hundred-year-old”. The buildings are seriously aged. Among them, problems with airtightness and thermal insulation of walls, doors, windows and other envelopes, airtightness and sound insulation of elevated timber floors and heat preservation and insulation of overall buildings, etc. seriously hinder the improvement of comfort in use.

The South Elevation Has a Poor Thermal Capacity

The south elevation, the most distinctive feature of Shanghai Lilong, i.e., the enclosing wall of south atrium in a Lilong building is mainly used to prevent fire and burglary, which makes the enclosing wall seriously affect direct solar heating capacity of south rooms on the first floor in winter. (Figure 3)

III. ECOLOGICAL PROTECTION AND RENOVATION STRATEGIES FOR LILONG

With respect to the above ecological problems, we propose the following renovation strategies for Lilong from the selection of building materials, construction practice and construction forms.

To Enhance the Performance of Envelop Materials

The original Lilong buildings were constructed in an early time. The building materials and means are relatively backward. The thermal performance of envelopes is poor. Therefore, we can use some new construction practices to reconstruct Lilong envelopes and renovate them ecologically. For example, we can pave a plastic ventilation film under timber floors. Add a floppy rock wool insulation layer between floor keels and add a thistle board under keels as finish of suspended ceiling. In this way, not only air permeability can be effectively prevented, but also airtightness, thermal insulation and sound absorption can be enhanced.

To Improve Airtightness

Lilong has perfect orientation and excellent shape coefficient. The pitched roof is designed with an adjustable ventilation device, to control thermal discharge in summer and heating in winter reasonably. But airtightness of envelopes must be addressed. The first step is to improve airtightness and thermal insulation of walls, floors, doors and windows. With these foundational improvements, the heat preservation ability of modified buildings can be greatly enhanced.

To Reconstruct Skylights

Due to a large-depth and small-width layout, Lilong has a lot of dark rooms, which have to take advantage of atrium lighting (generally known as rear rooms). For this, light pipes can be laid and some open skylights can be added, for example, compound PV skylights. The shading rate can be changed by altering the density of PV plates, to prevent excessive indoor thermal radiation and increase the lighting of dark rooms. Meanwhile, an open design can eliminate hot air inside the roof in summer, too.

Ground Source Heat Pump

Some Lilong will be changed into commercial real estates, such as shops and clubs, etc. In fact, users of these purposes are quite dependent on active equipment in these buildings. Therefore, to renovate Lilong ecologically, the energy efficiency of active equipment must be improved. At present, ground source heat pump system has become a mature technique and widely applied in the United States and other developed countries. It would be more energy efficient to use ground source heat pump system to reduce building energy consumption caused by air conditioning system, etc.

Rainwater Collection

Although Shanghai is located in a water-rich area, it is still a typical city short of quality-induced water. The pitched roof of Lilong can form a good rainwater collection platform naturally. Rain pipes can be directly interfaced with rainwater tanks through rain-sewage separators, for toilet flushing and landscape irrigation. (Figure 4)

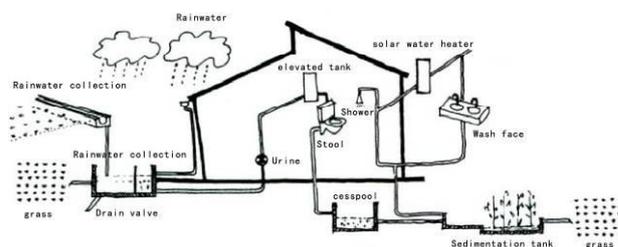


Figure 4: Rainwater Collection System

IV. CONCLUSION

Lilong is a residential building with regional characteristics formed in the historical development of Shanghai City. In a manner of speaking, the material space in Lilong interacts with resident activities and forms a unique dwelling form of Shanghai. The concept of Lilong protection used to refer to the protection of urban history and culture, as well as the material space representation of Lilong. However, with social development, people should protect and renovate Lilong from an ecological perspective, to make Lilong an extension of Shanghai people’s spiritual “home”.

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The Application Of Statistical Methods In The Study Of Relationship Between The Heating Temperatures Of Tire

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Abstract—By studying radial tire (car tires) , the relationship and the linear equations between the largest load of the car in high-speed performance test, the high-speed driving speed , the tire shoulder thickness and temperature fever are discussed and established by using regression analysis, variance analysis, experimental design, and other statistical methods according to the data provided by a tire company. This paper solved the impact of the best shoulder thickness, speed and maximum capacity, to the quality of tires in the effective temperature controlling.

Index Terms— Statistical methods, Tire quality, High-speed performance test, Fever temperature

I. INTRODUCTION

As the car tire and road direct contact parts, ground tire problems have an important effect on the performance of the car, have a direct impact on its performance, driving stability of vehicle comfort, fuel economy, dynamic braking, etc. In the 1970s-80s, the ordinary oblique structure tire of Japanese and South Korean were gradually transformed to the radial tire, while in the present the ordinary oblique structure tire of Japanese ,South Korean , China and other countries have been completely replaced by the brand-new radial tire[1,2]. One of the important characteristics of the radial tire is its rigid belt, and the surface adhesion, therefore resist lateral deviation resistance, so as to ensure the vehicle has good handling and stability. The burst of early tire were mainly caused by heating and fatigue. At present, the burst of early tire is not the main problem of tire damage because of the large-scale use of radial tire [3]. So ,in the current , the focus on tire of domestic and foreign has been transferred from tire burst to other tire quality[4], such as , the durability ,the surface residue and the plastic quality tires of the tire. The driving tire will produce a lot of heat under external loading, caused by temperature rise. Tire temperature rise is the main factor influencing the tire life. It mainly comes from two sources: one is the rubber material deformation and tire periodic hysteresis loss into heat; two is the friction heat of the ground. Tire material properties are closely related to temperature, overheating will lead to a serious decline in the performance of tire materials, resulting in rapid tire damage, therefore, to solve the heating problem of tire is still a very important research topic. Through the study of heating temperature of tire, a large number of data show that the maximum load, speed and temperature of tire and tire vehicle shoulder thickness.

In this paper, using SPSS statistical software and MATLAB programming for data processing; using the method of multivariate statistical analysis, establish the relationship model between the speed of the car at high speed, tire shoulder thickness, high speed performance test of maximum load and heating temperature, and the

model is related to inspection; analysis conclusion to determine the engineering conditions, so as to improve the quality of tire the purpose of.

II. THE ESTABLISHMENT OF DATA PROCESSING AND MODEL

A. Test data

Let x_1 be the largest load of the car in high-speed performance test(kg),let x_2 be the high-speed driving speed (km/hr),let x_3 (mm)(Because of the production process, accuracy and other reasons, can produce small changes) be the tire shoulder thickness, let y be the tire heating temperature determination of each test variable. We obtained the test data provided by a company as follows:

TABLE I.
EXPERIMENTAL DATA

| Testing sequence | x_1 | x_2 | x_3 | y |
|------------------|-------|-------|-------|-------|
| 1 | 1570 | 60 | 35 | 79 |
| 2 | 1570 | 60 | 35.5 | 74.2 |
| 3 | 1570 | 60 | 37.5 | 77.4 |
| 4 | 1570 | 90 | 36 | 89.6 |
| 5 | 1570 | 90 | 34.5 | 97.5 |
| 6 | 1570 | 90 | 37.5 | 90 |
| 7 | 1570 | 120 | 36.5 | 121.5 |
| 8 | 1570 | 120 | 34.5 | 92.7 |
| 9 | 1570 | 120 | 40 | 92.5 |
| 10 | 2620 | 60 | 34.8 | 109.6 |
| 11 | 2620 | 60 | 36.5 | 104.5 |
| 12 | 2620 | 60 | 37 | 104.8 |
| 13 | 2620 | 90 | 35 | 160.3 |
| 14 | 2620 | 90 | 36.5 | 124.5 |
| 15 | 2620 | 90 | 38.5 | 121.9 |
| 16 | 2620 | 120 | 34 | 212.9 |
| 17 | 2620 | 120 | 34 | 163.1 |
| 18 | 3668 | 120 | 37.3 | 151.1 |
| 19 | 3668 | 60 | 34.8 | 165.4 |
| 20 | 3668 | 60 | 35.1 | 145.3 |
| 21 | 3668 | 60 | 37.8 | 132 |
| 22 | 3668 | 90 | 33.5 | 223 |
| 23 | 3668 | 90 | 36.3 | 169.3 |
| 24 | 3668 | 90 | 35.8 | 156.4 |
| 25 | 3668 | 120 | 34.5 | 294.6 |
| 26 | 3668 | 120 | 35 | 213.4 |
| 27 | 3668 | 120 | 36.3 | 193.9 |

B. Data standardization

We use -1, 0 and 1 on behalf of 3 different level loads separately; use -1, 0 and 1 on behalf of 3 different level speeds separately. With table 1, let the data x_1 and x_2 be standardized according to table 2, we obtain the table of standardized data:

TABLE II.
STANDARDIZED CRITERIA

| | | | |
|---------------|------|------|------|
| x_1 (kg) | -1 | 0 | 1 |
| | 1570 | 2620 | 3668 |
| x_2 (km/hr) | -1 | 0 | 1 |
| | 60 | 90 | 120 |

TABLE III.
STANDARDIZED DATA

| Testing sequence | x_1 | x_2 | x_3 | y |
|------------------|-------|-------|-------|-------|
| 1 | -1 | -1 | 35 | 79 |
| 2 | -1 | -1 | 35.5 | 74.2 |
| 3 | -1 | -1 | 37.5 | 77.4 |
| 4 | -1 | 0 | 36 | 89.6 |
| 5 | -1 | 0 | 34.5 | 97.5 |
| 6 | -1 | 0 | 37.5 | 90 |
| 7 | -1 | 1 | 36.5 | 121.5 |
| 8 | -1 | 1 | 34.5 | 92.7 |
| 9 | -1 | 1 | 40 | 92.5 |
| 10 | 0 | -1 | 34.8 | 109.6 |
| 11 | 0 | -1 | 36.5 | 104.5 |
| 12 | 0 | -1 | 37 | 104.8 |
| 13 | 0 | 0 | 35 | 160.3 |
| 14 | 0 | 0 | 36.5 | 124.5 |
| 15 | 0 | 0 | 38.5 | 121.9 |
| 16 | 0 | 1 | 34 | 212.9 |
| 17 | 0 | 1 | 34 | 163.1 |
| 18 | 1 | 1 | 37.3 | 151.1 |
| 19 | 1 | -1 | 34.8 | 165.4 |
| 20 | 1 | -1 | 35.1 | 145.3 |
| 21 | 1 | -1 | 37.8 | 132 |
| 22 | 1 | 0 | 33.5 | 223 |
| 23 | 1 | 0 | 36.3 | 169.3 |
| 24 | 1 | 0 | 35.8 | 156.4 |
| 25 | 1 | 1 | 34.5 | 294.6 |
| 26 | 1 | 1 | 35 | 213.4 |
| 27 | 1 | 1 | 36.3 | 193.9 |

C. Calculation of correlation coefficient matrix

In order to obtain the relationship between x_1, x_2, x_3 and y , we calculated the correlation coefficient between x_1, x_2, x_3 and y .

Let $E(X)$ be the expected value of random variable X ; Let $D(X)$ be the variance of random variable X ; Let $Cov(X,Y)$ be the covariance of two dimension random variable (X,Y) ; Let ρ_{XY} be the correlation coefficient of two dimension random variable (X,Y) .Then:

$$D(X) = E(X - E(X))^2 \tag{1}$$

$$Cov(X,Y) = E[(X - E(X))(Y - E(Y))] \tag{2}$$

If $D(X) > 0, D(Y) > 0$, then:

$$\rho_{XY} = \frac{Cov(X,Y)}{\sqrt{D(X)}\sqrt{D(Y)}} \tag{3}$$

If $\rho_{XY} = 0$, we say that X and Y is irrelevance;

If $\rho_{XY} = 1$, we say that X and Y is being perfect positive correlation;

If $\rho_{XY} = -1$, we say that X and Y is being completely inverse related;

If $0 < |\rho_{XY}| < 1$, we say that X and Y is being perfect negative correlation [5].

Using the data in Table 3, With formula (1), (2) and (3), we obtain the correlation coefficient matrix between x_1, x_2, x_3 and y as follows according to table 4.

TABLE IV.

THE CORRELATION COEFFICIENT MATRIX BETWEEN x_1, x_2, x_3 , AND y

| | | | | |
|-------|----------|----------|----------|----------|
| | x_1 | x_2 | x_3 | y |
| x_1 | 1 | 0 | -0.25699 | 0.768856 |
| x_2 | 0 | 1 | 0.049542 | 0.243035 |
| x_3 | -0.25699 | 0.049542 | 1 | -0.03549 |
| y | 0.768856 | 0.243035 | -0.03549 | 1 |

The table 4 shows that the correlation coefficient between x_1 and y is 0.768856, so x_1 has great influence on y . The correlation coefficient between x_1, x_2 and x_3 on y is so little that we can approximately consider x_1, x_2 and x_3 as independent variables.

D. The establishment of the multiple linear regression equation

• The introduction of the multiple linear regression equation [6]

By making n observations and computations, we obtained an ideal multivariate linear regression analysis mathematical model of $y_i = \beta_0 + \beta_1 x_{i1} + \dots + \beta_p x_{ip} + \varepsilon_i (i = 1, \dots, n)$ if the dependent variable y and the independent variables x_1, x_2, \dots, x_p has the linear relationship of $y = \beta_0 + \beta_1 x_1 + \dots + \beta_p x_p + \varepsilon$, where $\beta_0, \beta_1, \dots, \beta_p$ are estimate parameters, and y, x_1, \dots, x_p are variables which can be observed. $\varepsilon_i (i = 1, \dots, n)$ is the random error of the observation and computation of the i^{th} . Since $\varepsilon_i (i = 1, \dots, n)$ is the random error, we can suppose the average value of them is zero, in other words, $E(\varepsilon_i) = 0$. In addition, we always suppose $\varepsilon_i (i = 1, \dots, n)$ satisfies the Gauss-Markov supposition, that is to say,

$$Var(\varepsilon_i) = \sigma^2, i = 1, \dots, n$$

$$Cov(\varepsilon_i, \varepsilon_j) = 0, i \neq j$$

The first supposition indicate the variances of $\varepsilon_i (i = 1, \dots, n)$ are equal. The second requests the error of the different experiment and observation of is non-correlated. In the practical application, these suppositions are often approximately established. And $\varepsilon_i (i = 1, \dots, n)$ must be mutual independences which obey the identical normal distribution of $N(0, \sigma^2)$.

In order to write conveniently, we introduce the matrix symbol, let,

$$y = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix}$$

$$X = \begin{bmatrix} 1 & x_{11} & \dots & x_{1p} \\ 1 & x_{21} & \dots & x_{2p} \\ \vdots & \vdots & & \vdots \\ 1 & x_{n1} & \dots & x_{np} \end{bmatrix}$$

$$\beta = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_p \end{pmatrix}$$

$$\varepsilon = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix}$$

Then this regression model and the Gauss-Markov supposition can record as follows:

$$y = X\beta + \varepsilon, E(\varepsilon) = 0, Cov(\varepsilon) = \sigma^2 I$$

Where y is the observation vector of $n \times 1$, β is the unknown parameter vector of $(p+1) \times 1$, β_0 is an absolute term, $(\beta_1, \beta_2, \dots, \beta_p)^T$ is the regression coefficient is the design matrix of $n \times p$, ε is the random error vector of $n \times 1$, $Cov(\varepsilon)$ is the covariance matrix, and I is the unit matrix of n . We can record the supposition of the error as $\varepsilon \sim N(0, \sigma^2)$ when the errors obey the identical normal distribution.

• **The establishment of the multiple linear regression equation**

The use of normalized data (Table 3), Using x_1, x_2 and x_3 as independent variable and using y as dependent variable, we can obtain the coefficient of the multiple linear regression equation between x_1, x_2, x_3 and y as follows with the SPSS software, obtained was 5 [7]:

TABLE V.
THE COEFFICIENT OF THE MULTIPLE LINEAR REGRESSION EQUATION

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig |
|----------|-----------------------------|--------------------|---------------------------|--------|------|
| | b | Standardized Error | | | |
| Constant | -248.7245 | 169.181 | | -1.470 | .155 |
| x_1 | 0.0509 | .008 | .810 | 6.580 | .000 |
| x_2 | 0.5160 | .262 | .235 | 1.973 | .061 |
| x_3 | 5.9131 | 4.525 | .161 | 1.307 | .204 |

Therefore, the multiple linear regression equation as follows:

$$\hat{y} = 0.0509x_1 + 0.5160x_2 + 5.9131x_3 - 248.7245 \quad (4)$$

III. MODEL TEST

A. Analysis of the significant test and variance of the regression equation with multiple correlation coefficient

• **Analysis of significance test and variance of the regression equation with correlation coefficient of steps**

The steps are as follows [8]:

Let SST be the total change, Let SSR be the regression change, and let SSE be the residual change, then.

$$\begin{aligned} SST &= \sum (y_i - \bar{y})^2 = \sum (y_i - \hat{y}_i + \hat{y}_i - \bar{y})^2 \\ &= \sum (\hat{y}_i - \bar{y})^2 + \sum (y_i - \hat{y}_i)^2 \\ &= SSR + SSE \end{aligned} \quad (5)$$

Where:

$$\begin{aligned} SSR &= \sum (\hat{y}_i - \bar{y})^2 \\ SSE &= \sum (y_i - \hat{y}_i)^2 \end{aligned} \quad (6)$$

$$\sum \hat{y}_i = \sum y_i = n\bar{y}$$

Let:

$$\hat{Y} = \begin{bmatrix} \hat{y}_1 \\ \hat{y}_2 \\ \vdots \\ \hat{y}_n \end{bmatrix} = \begin{bmatrix} \hat{\beta}_0 + \hat{\beta}_1 x_{11} + \dots + \hat{\beta}_k x_{k1} \\ \hat{\beta}_0 + \hat{\beta}_1 x_{12} + \dots + \hat{\beta}_k x_{k2} \\ \vdots \\ \hat{\beta}_0 + \hat{\beta}_1 x_{1n} + \dots + \hat{\beta}_k x_{kn} \end{bmatrix} \quad (7)$$

$$= \begin{bmatrix} 1 & x_{11} & \dots & x_{k1} \\ 1 & x_{12} & \dots & x_{k2} \\ \vdots & \vdots & & \vdots \\ 1 & x_{1n} & \dots & x_{kn} \end{bmatrix} \begin{bmatrix} \hat{\beta}_0 \\ \hat{\beta}_1 \\ \vdots \\ \hat{\beta}_k \end{bmatrix} = X\hat{\beta},$$

Then:

$$SST = Y'Y - n(\bar{y})^2 \quad (8)$$

$$SSR = \hat{Y}'\hat{Y} - n(\bar{y})^2 = \hat{\beta}'X'X\hat{\beta} - n(\bar{y})^2 = \hat{\beta}'X'Y - n(\bar{y})^2 \quad (9)$$

Residual changes:

$$SSE = SST - SSR = Y'Y - \hat{\beta}'X'Y \quad (10)$$

By (5) - (10), by variance analysis of table 6:

TABLE VI.
THE TABLE OF VARIANCE ANALYZING OF MULTIPLE REGRESSION

| variance origin | S | φ | V | F_0 | $F(\alpha)$ |
|-----------------|--|-----------|-----|-------------------|-----------------------|
| regression | $SSR = \hat{\beta}'X'Y - n(\bar{y})^2$ | k | MSR | $\frac{MSR}{MSE}$ | $F(k, n-k-1; \alpha)$ |
| residual | $SSE = Y'Y - \hat{\beta}'X'Y$ | $n-k-1$ | MSE | | |
| Sum total | $SST = Y'Y - n(\bar{y})^2$ | $n-1$ | | | |

Where:

$$F_0 = \frac{MSR}{MSE} \quad (11)$$

The regression mean square as follows:

$$MSR = \frac{SSR}{k} \quad (12)$$

The residual mean square as follows:

$$MSE = \frac{SSE}{n-k-1} \quad (13)$$

If $F_0 = \frac{MSR}{MSE} > F(k, n-k-1; \alpha)$, we rejects the null

hypothesis in the significance level α , where:

$$H_0 : \beta_1 = \beta_2 = \dots = \beta_k = 0 \quad (14)$$

By now, the regression equation was precise, and the larger of F_0 , the precise of the regression equation.

The goodness of fit coefficient test is one of the popular methods in determine the precision of the regression equation.

$$R^2 = \frac{SSR}{SST}$$

The value of R^2 is between 0 and 1, and the larger of R^2 , the precise of the regression equation.

- **To solve the significant test and variance analysis using complex correlation coefficient**

According to the data provided by a factory, (5) - (14), With the SPSS software [9], we can obtain the table of statistical result as follows 7 and 8.

TABLE VII.
STATISTICAL RESULT

| | | | |
|-------|-------|-------------------------|----------------|
| r | r^2 | the adjustment of r^2 | standard error |
| 0.821 | 0.674 | 0.632 | 33.24530 |

TABLE VIII.
VARIANCE ANALYZING

| Source | the sum of squares of variance | degree of freedom | variance | F | p |
|-----------------|--------------------------------|-------------------|-----------|--------|------|
| Corrected Total | 52647.902 | 3 | 17549.301 | 15.878 | .000 |
| Error | 25420.748 | 23 | 1105.250 | | |
| Total | 78068.650 | 26 | | | |

And

$$R^2 = \frac{SSR}{SST} = 0.821$$

The establishment of the multiple linear regression equation (4) is quite precise because the R^2 is so close to 1.

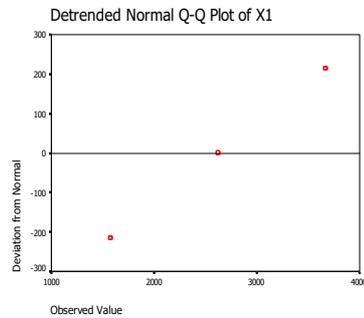
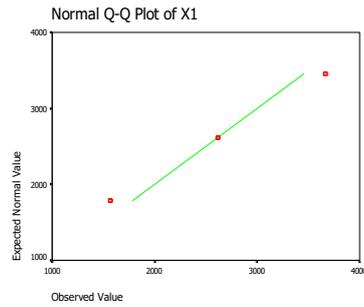
According to the analysis of variance in Table 8, the regression equation is effective.

B. Normality tests

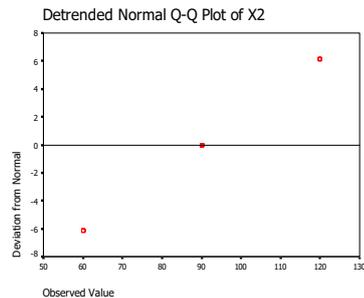
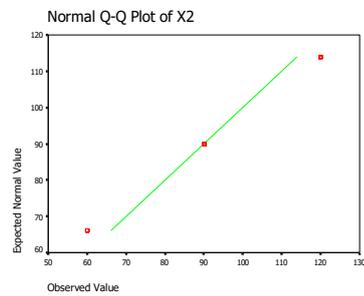
In many statistical methods, the quality of statistical inference depends on the normal degree of sample data. Therefore, it's very essential to test the difference between these data and the normal population. Examining a random variable whether obey the normal distribution is called normality examination. There are many examination methods, such as goodness of fit test. This article applied the Q-Q chart inspection method to test the difference between these data and the normal population. The principle of the Q-Q chart examination is taking the quintile of the normal population as x-coordinate, taking the quintile of the sample as y-coordinate to map, if the graph is a approximate straight line, then we say this sample is a normal population [10].

- **Figure Q-Q**

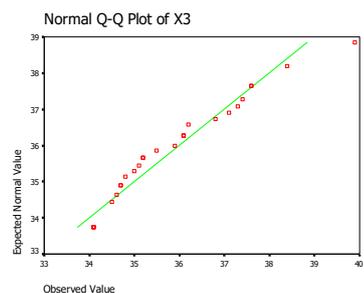
With the SPSS software, we obtain the Q-Q normal probability charts of x_1, x_2, x_3 and y as follows according to the data provided by a company (Table 1):

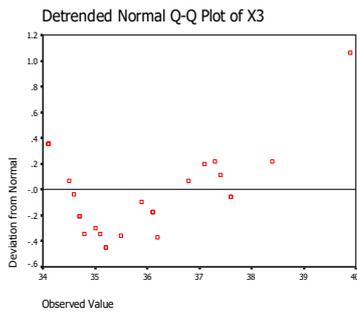


a) The Q-Q normal probability charts of x_1

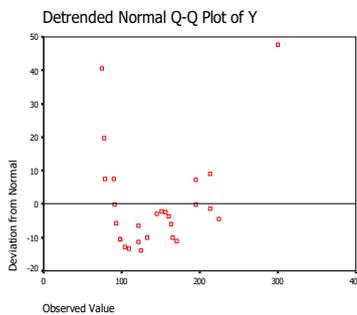
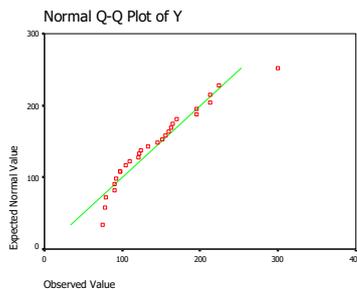


b) The Q-Q normal probability charts of x_2





c) The Q-Q normal probability charts of x_3



d) The Q-Q normal probability charts of y

Figure 8. The Q-Q normal probability charts of x_1, x_2, x_3 and y

The fig1 shows that the scatter diagram is an approximate straight line, so we think the data approximately from a normal population.

• **Residual analyzing**

By using multiple linear regression in statistical toolbox of MATLAB regress [11] function, processing the data of the 27 groups of known, by the multiple correlation coefficient $R=0.6744$, F value of 15.8781, significant probability $P=0.0000$, using rcoplot() function residual map.

We can obtain the residual chart of the multiple linear regression equation as follows with the rcoplot() function of MATLAB[6]:

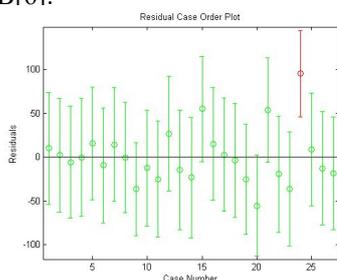


Figure 8. Residual chart

Fig 2 shows that the residual nearly fall into a change scope not big scallop, so the multiple linear regression equation satisfies the basic supposition.

C. Significant test of regression equation -- F test

The discussion in front of all variables in regression equation the overall regression effect, but the overall regression effect and cannot fully explain each of the independent variables x_1, x_2, x_3 on the dependent variables y are important, There may be an independent variable x_i don't work for y , or can be replaced by other x_k effects, the independent variables can be excluded from the regression equation, so the regression equation could be established more simple. If an argument if the effect is not significant, its coefficient should be 0. If an argument if the function of y is not significant, while the coefficient of β_i it should be 0.

Significant test of multivariate linear regression equation is to look at the arguments of x_1, x_2, x_3 from the whole of the random variable whether y obvious influence has.

The original hypothesis:

$$H_0 : \beta_1 = \beta_2 = \beta_3 = 0$$

Procedures for the preparation of MATLAB [12] can be obtained by variance analysis of Table 9.

Because

$$F_0 = \frac{MSR}{MSE} = 15.878 \text{ and } F(0.01) = 4.76.$$

So

$$F_0 = \frac{MSR}{MSE} > F(k, n - k - 1; \alpha)$$

Therefore we can assert independent variable x_1, x_2, x_3 have obvious influences on random variable y by 99.9% above probability and the regression equation is precise.

D. Decision analyzing

It is empirical that the tire is easy to burst when the temperature of the heat given off by the tire is higher than 150 °C .We should solve the last problems with the multiple linear regression equation:

(1) How much x_3 can we guarantee the temperature of the tire is lower than 150 °C when x_1 is 2620kg and x_2 is 90km/hr?

(2) How much x_1 and x_2 can we guarantee the temperature of the tire is lower than 150 °C when x_3 is 30mm(national normal value) ?

Solve: (1) Let $x_1 = 0, x_2 = 0$, $\hat{y} = 150$ substitute into the regression equation (4), then,

$$150 = 5.9131x_2 - 248.7245$$

The limit value of x_3 is as follows:

$$x_3 = 67.4307$$

Let $x_1 = 2620$, $x_2 = 90$ substitute into the regression equation (4), then,

$$\hat{y} = 0.0509 \times 2620 + 0.5160 \times 90 + 5.9131x_3 - 248.7245$$

We can obtain

$$x_3 < 37.0240$$

with the formula of (23) when $\hat{y} < 150$.

Therefore we can guarantee the temperature of the tire is lower than 150 °C when the thickness of the tire shoulder is lower than 37.0240mm.

(2) Let $x_3 = 30$ substitute into regression equation (4), then,

$$\begin{aligned}\hat{y} &= 0.0509x_1 + 0.5160x_2 + 5.9131 \times 30 - 248.7245 \\ &= 0.0509x_1 + 0.516x_2 - 71.3315\end{aligned}$$

We can obtain:

$$x_2 < 428.9370 - 0.0986x_1$$

With the formula of (25) when $\hat{y} < 150$.

We can obtain the figure 3. With the MATLAB software, and the underneath of the straight line is the solution of the formula of (26).

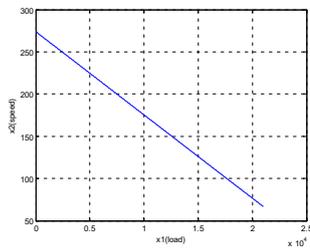


Figure 8. The scopes of x_1 and x_2

We can guarantee the temperature of the tire is lower than 150°C when the scope of x_1 is 0 kg -2100 kg and the scope of x_2 is 70 km/hr-275 km/hr according to the fig 3.

IV. CONCLUSIONS

By studying radial tire (car tires), the relationship and the linear equations between the largest load of the car in high-speed performance test, high-speed driving speed, tire shoulder thickness and temperature fever are discussed and established by using regression analysis, variance analysis, experimental design, and other statistical methods according to the data provided by a tire company.

This paper calculated the correlation coefficients between the largest load of the car in high-speed performance test (x_1), the high-speed driving speed (x_2), the tire shoulder thickness (x_3) and temperature fever (y), and the result demonstrated that x_1 has great influence on y while the correlation coefficient between x_1 , x_2 and x_3 is so little that we can approximately consider x_1 , x_2 and x_3 as independent variables. So we can obtain the multiple linear regression equation between x_1 , x_2 , x_3 and y with the program of SPSS software. We can see from the multiple linear regression equation that as the largest load of the car in high-speed performance test (x_1) increases a unit of 1120kg the temperature increases 57.008°C , that as the high-speed driving speed (x_2) increases a unit of 30km/hr the

temperature increases 15.48°C , that as the tire shoulder thickness (x_3) increases a unit of 1mm the temperature increases 5.9131°C .

It is empirical that the tire is easy to burst when the temperature of the heat give off by the tire is higher than 150°C . Therefore we can guarantee the temperature of the tire is lower than 150°C when the largest load of the car in high-speed performance test (x_1) is 2620kg, the high-speed driving speed (x_2) is 90km/hr and the tire shoulder thickness (x_3) is lower than 37.0240mm., we can guarantee the temperature of the tire is lower than 150°C when the tire shoulder thickness (x_3) is the national normal value of 30mm, the scope the largest load of the car in high-speed performance test (x_1) is 0 kg -2100 kg and the scope of the high-speed driving speed (x_2) is 70 km/hr-275 km/hr.

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A Study on Symbol of Color Cultural in Web Page Design

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Abstract—Color, as a form of artistic expression, is an important part of aesthetics. It can arouse people to understand and appreciate the image and content of their expression from the aesthetic sense, the meaning of web color design is also as this. Color is not only the expression language of website works, but also ways and means of visual communication, so the good using of color is very important. At present, most papers analyze color from view of the color itself or its' psychological characteristic, or the relationship between color and web design, but few of them focus on cultural symbolism of color. From the perspective of cultural symbolism of color, this article discusses the guidance function of cultural symbolism to the use of color in web color design. It is a deeper thinking about color design of pages.

Index Terms—Web design, traditional colors, color cultural symbol

I. INTRODUCTION

A. The importance of webpage color design

Color and our life are inseparable, it's magical powers will decorate colorful nature, cultivate our hearts, give us a feeling of beauty and visual aesthetic pleasure. Psychological research shows that the human visual organ in the observation of the object, within the first few seconds, the percentage of color perception is 80%, and 20% for the physical sensation; Two minutes later, it become 60% for color perception and 40% for the physical sensation. So when a user opens a Web page, a first impression is not its content or layout arrangement, but the color. It has characteristics that easily be watched and perceived, and can left a deep impression durably to the browsers. For the photo shown in Figure 1, when we look at it at first glance, what attracts us is the red on female's face. Out of curiosity, we wonder why the designers would do such a design. After thinking about the colors that attract us, we will go to consider the content of the site.



Figure 1. Color that used in webpage

Color subconscious affects browsers of the site, but also has close contact with the user experience. It is important to learn about make good use of color, to convey the theme of the site by color design and to

convey the essence and message with the correct color. When the color is conveyed properly, it can arouse people's hearts perception, generate spiritual resonance with browser and inspire the emotion and the desire for experience of the browsers, so as to better convey information of website and reach the dual purpose of information transmission and emotional communication.

B. The web page color and cultural symbol

Good color design of website gives a strong visual impact and artistic appeal to browsers. The performance of emotion and meaning will affect users from the senses to thinking, which yield some understand and memory. So how it trigger this emotion understand and memory?

The color itself can give people the physiological stimuli. On the other hand, it has been endowed the concepts that the true color do not have in the social development process, which are derived from experiences, but mostly around for centuries of tradition. We call this concept or tradition as a symbol of color, whether it is China or the West, we should not only focus on the visual perception of color but more should be concerned about the symbolism of color, the color design of the site is as well.

When consider what kind of color should select and apply for a site, we first must make it coincide with the theme of the site, because each color has its own particular emotional expression, deep symbolic significance and special meaning in people's minds.

Speaking in GuangYuan Li's book Color Comparison of East and West: "color symbolizes is main spirit base of color's apply way for the ancient peoples of East and West, ... On the surface, when making self-discipline choice of color symbolism, the ancient nations are mainly affected by color information within specific ethnic environment... "So, whether China or the West, we should not only focus on the visual perception of color but more concerned about color symbolism.

China has a long history of outlook for color called traditional five element view. West has a system of strict scientific color system. People from east and west are in accordance with their cultural values and spirit to know the color, but also according to their cultural values and spirit to create a color symbol. Chinese traditional five colors: cyan (blue), yellow, red (red), white, black, in both color system, a symbol of the same color can be same or different, only a good grasp of color symbolism can we better use the color to fully express the subject and national culture of a website.

II. CONTENT

In this section, this paper talks about the use of Chinese traditional color culture symbol in Web design.

Shuo Wen Jie Zi said: "color, qi of the face also, face is between the two eyebrows, when the qi reach the eyebrows called color ... ". This is the comment to color in Xu Shen's Shuo Wen Jie Zi. "Color" is the qi of face, so what the qi is? Qi is the person's mental state. From this we can infer that the ancient people considered color shows a state of the person or object. Famous modern

color scientist Johannes • Eaton in the Art of Color, a book wrote "Color is a concept from the primitive times there is the original colorless light and relatively free of color dark births."

The traditional Chinese color view was established more than 2,000 years ago, from colorless to both yin and yang color then to the traditional five element color system, which emphasizing the subjective ethics. The Western view is the color from light to RGB color then to all color of the spectrum system, their thinking and observation way is rational analysis and induction for the phenomenon and nature of color, which was good at tracing the source and was strict and scientific system.

Such a different way of seeing color is caused by different regions, different cultural influences. It is because of this concept of different color view, plus the different political, economic, cultural, forming a different color symbolism between east and west.

A. Object is born of - Blue

"Green, means live, is the symbol at birth." Zuo Zhuan records: "One people called Blue Bird command the beginning". Wang Yu Note: "Blue Bird, tweet from the beginning of spring to the end of summer". Tells us Blue Bird is responsible for the beginning of spring to the beginning of summer calendar judge, called the beginning birds. Later, many literary works often relate Blue bird and spring and things grow together.

From southern king Wang Rong's three days Qushui order, they viewed blue bird as spring messengers image. Beautiful symbol of Bluebird also give the same meaning to the blue color. Figure 2 is a protected species in Japan Website cyan color, the use of this comes from the blue sky, reflecting the spiritual core of the site from the color that animals and humans have the same right to life. They hope people to show their love for the animal to retain a little better living space.



Figure 2. A species protect Website of Japan

In the west blue has the different symbolic meaning with in China, but it is equally welcomed by the people. According to the survey it was 40 percent of men and 36% of women's favorite color. There is no one does not like blue, because it represents the goodwill, harmony and friendship. Blue has this status in hearts of people in the West also evolved step by step.

It is believed that the gods live in the sky, and blue is the color around them. When God becomes human form, they sometimes use blue skin as its flag from the sky, like the Indian god Krishna did. Most gods came to earth

wearing blue gown, and blue symbolizes their connection with heaven. As the color of gods, blue represents the eternal, as eternal color blue is a symbol of truth.

B. Imperial color - yellow

"Yellow, means dazzle, like the color of sunlight is shaking also." Yellow is the neutral color, yellow and "medium" are fused, so the yellow is the color of earth. This color represents the beauty of heaven and earth, but also the beauty of "neutralization", so it has become respected color.

In China, yellow ranks among the five parties to dominate the place, is considered the color of the emperor. The king Tang Taizong provisions, in addition to the emperor can with yellow clothes, ordinary people cannot with red yellow clothed. In Chinese tradition, yellow is typical social symbol for rich majestic, sublime.

In the West yellow also has a bright symbol. In Van Gogh's Sunflowers, the sun is equal sunflower and loving is the subject of the painting. Van Gogh made a good effort to change the combination also made yellow better by to perfection. At the same time the other picture of Van Gogh named Night open-air cafes, depicts a scene outside the cafe, indoor warm yellow light shines on the cobblestone square outside the house, it is so warm and comfortable. Why yellow so beloved by the great painter. It is because yellow has optimism like sun. Yellow color as the sun symbol appears in the West and it also on behalf of the sun god Helios, Apollo, Solomon.

Yellow is the color of ripe, golden ear, golden fruit, golden leaves, golden autumn. In the Crows Catcher Crows are just some black lines, pressed against the large ripe orange wheat field, the whole picture is filled with beige romanticism.

C. The sun color—Red

"Red, is the sun color." This view is different with the West. Westerners think yellow is the color of the sun. Chinese red as a symbol has a long history, from a lot of historical data, we can infer that the traditional Chinese red symbolizes relate the blood and the worship to sun and fire of the ancients.



Figure 3. A presentation of English webpage to introduce Chinese Wedding.

Modern Chinese people respect red. In addition to symbolism associated with the regime, red is also a symbol of good luck, celebration, happiness and so on. In every traditional festivals and weddings, people are decorated in red as the main colors. But in ancient times, red had more complicated symbolism: first, red is a symbol of honor, The Book of Rites records: "Red for emperor, dark green for princes, dark green for officer...." Red is a vocabulary related with nobleman's house. In the palace of the Qing Dynasty, the ladies were not allowed to wear red and green; secondly, red is auspicious symbol popularized in the Ming and Qing Dynasty and continues to this day: in the wedding birthday, festive red, is extensively used, as red hi word, red scarf, red candles,

red sedan, and even red chopsticks, red eggs, red underwear, red couplets and so on. Figure 3 is a presentation of English webpage to introduce Chinese Wedding. It use traditional Chinese red paper-cut as the body of the site.

In Western red symbolism is influence by two basic experiences: red for blood, red for fire. Red, is the color of war. Mars -- god of war was given a red color. Red gave people strength, therefore knight wear red dress. Until the 19th century, red was still common color for soldiers' clothing, red uniforms symbolized the powerful army. For example, in the site of Fig 6, the website war child is committed to protecting and supporting children affected by armed conflict, red as the main color is to attract attention: in this era of peace, some parts of the world, there are still such a group of children affected by war and are suffering the pain of war.

D. Fresh ice color--white

White, is the color of new ice. White is the color of mourning in ancient China, the mourners used white things, called "ordinary car and white horse". The mourners who wear white clothes and white hat, called "Plain Clothing". Modern folk funeral has been also in use with white. It is also a symbol of shallow knowledge, no fame, such as saying of the civilian population as "Bai Ding", "white clothing" and so on. White is also a symbol of failure, unprofitable, such as the losing side takes white flag when surrendered.

The Tibetans thought that white is the most sacred color. "Holy Hada" shows sincere heart. The White Pure God, meaning immaculate, no trouble. White Pure Career symbolizes charity. White Pale Road is a symbol of liberation and to obtain the good way.



Figure 4. A wedding webpage

Westerners think elegant pure white, is a symbol of innocence. It is Western culture's advocating colors. As the bride wore a white dress at the wedding, represents purity and chastity of marriage of love. As shown in figure 4 is a wedding site.

In the West, white is a color of God. In Europe, the incarnation of Zeus is white bull; the Holy Spirit manifested as white doves; Jesus Christ is white lamb; white unicorn beast is as a symbol of the Virgin Mary.

E. Sky color--Dark

In ancient China black is called Tianxuan, in China's culture it has a heavy sense of mystery, his symbolism is divided into two aspects: one symbolizes serious, such as The Untouchables Justice Bao's face is black. On the other hand it gives a dark light, sinister feeling of terror. This two view are obviously reflected in both Taoist and Tibetan Buddhism.

Black is the color symbol of Taoism, is a "mysterious" color in Taoism. In the Taoist yin and yang theory, black is the symbol of universe. Faced with colorful world, the

painters perform nature by black and white ink, trying to achieve the "Road" level, which is obviously influenced by Taoism "metaphysics" Thought. Taoism advocates black, think black living above all other colors, is the color of the dead, and is the color of heaven and earth transcendent life and death. Taoist buildings are mostly in black.

Painter Wassily Kandinsky describes black as follows: "Black knocking in the depths of the soul, as nothingness of no possibility, like the silence of emptiness after the sun goes out, as permanent silence of no future, no hope." Westerners think, at the end of all the material they are black, such as: rotten flesh, decaying plants, necrotic teeth. In color symbolism of Christian, black is the color of death and sorrow, and white is the color of resurrection. So mourning is black, and the deceased's clothes are white, because they need the resurrection.

These similar or different points, not only appear in China and West's color symbol, but also exist in different parts of China or the West. A very rich cultural world will form with these symbolic colors. However, everything has two sides, good use of these colors symbolize things can give a richer culture, on the contrary may have adverse consequences. Symbol of color, should change with times and reflect the society. Only if we have a good grasp of the symbolic significance of these colors can make better use of color to convey a social philosophy, ideology and cultural phenomenon.

III. CONCLUSION

Traditional web visual design for color studies is often not deep enough, could not consider from the color-cultural perspective, which ignores some deep impact factors to users. Designers should be based on the cultural background of different ethnic and geographical, combined the cultural trait to determine the color that can reflect their culture. Determine the main color of the entire site, namely to find the most representative image of the typical color scheme in the area, not only with respect to other areas constitute a "special" point, but also is integral in the area inside the generality. Color cultural derive from people's life atmosphere, has become the overall background and cultural needs of the user experience. A web design only when it base on color cultural symbol, can it better reflect the theme of the site and national cultural heritage.

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Design of Predictive Global Sliding Mode Variable Structure Controller

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Abstract—For a class of uncertain discrete systems, considering the chattering, arrival time, robustness, this paper proposes a predictive control strategy based on global sliding mode variable structure control. The main idea is on the basis of global sliding mode variable structure control, adopting the feedback correction and receding horizon optimization of predictive control to optimize the reaching process of sliding mode. The algorithm for the uncertain disturbance upper bound is not requested, the system state from the beginning to fall on the sliding surface and reducing the time of arrival. The designed system for matching and non-matching parameter perturbations and external disturbances are robust, weaken the chattering. The numerical simulation provides evidence for its effectiveness and efficiency.

Index Terms—Uncertain discrete-time system; Chattering; Robustness; Predictive control; Global sliding mode control

I. INTRODUCTION

The sliding mode variable structure control has a lower demand on the model of system. It is easy to realize its control algorithms and has a strong robustness when it meets parameter perturbation or external interference[1-2]. The sliding mode variable structure control method is widely applied in practical engineering[3-7]. With the development of intelligent, discrete-time sliding mode variable structure system research become a hot spot[8-11]. Anti perturbation and anti-disturbance ability only exists in the sliding mode phase, and its robustness is work only meet matching parameter perturbation and external disturbance. To the question of the system's uncertainty, the literature [12] puts forward an adaptive fuzzy sliding mode control architecture and uses a new matching criteria to handle the uncertainty,. The literature [13] and [14] use predictive control and neural network respectively, with the method of combination with the sliding mode variable structure control to handle the uncertainty. The literature [15] put forward a new control strategy by using an improved reaching law combined with the predictive control, which has completely robustness to the system's external perturbation and uncertain demands. It is another direction that shorten the sliding time of arrival, improving the dynamic properties of the system and robustness[16-17].

For the discrete-time systems, in order to ensure the robustness in the mismatching system and matching uncertain system, and exhibits better dynamic properties, the predictive control of feedback correction and rolling optimization idea is introduced into sliding mode variable structure control. Using this algorithm reduced the time reach the sliding mode surface, suppress the influence of parameter perturbation and external disturbance.

II. PROBLEM DESCRIPTION

Consider the following uncertain discrete-time system $x(k+1) = (A + \Delta A)x(k) + (B + \Delta B)u(k) + d(k)$ (1)

Where (A, b) is assumed controllable completely; $x(k) \in R^n$ is the system state vector; $u(k) \in R^m$ is the system control input, (A, B) controllable, ΔA and ΔB are parameter perturbation of the system, $d(k)$ is external disturbance.

The effect of ΔA , ΔB , $d(k)$ is equal to a disturbance

$$f(k) = \Delta Ax(k) + \Delta Bu(k) + d(k) \quad (2)$$

the equation(1) corresponds to the nominal system:

$$x(k+1) = Ax(k) + Bu(k) \quad (3)$$

The design goal of this paper is to design a sliding mode variable structure controller, which enables to achieve the expected performance index: short the arrival time, eliminate chattering, completely no deformation to parameter perturbation and external disturbance.

III. THE MAIN RESULTS

2.1 The design of the global sliding surface

The sliding mode switching function is defined as

$$s(k) = Cx(k) - Ce^{-\lambda k}x(0) \quad (4)$$

where C is the n dimensional row vector; $\lambda > 0$ as the adjustable parameter. To ensure stability and dynamic performance can use the measure of pole assignment to determine and choose the appropriate C .

2.2 The design of the sliding mode prediction model

Construct the following sliding mode prediction model for the equation (3)

$$s_m(k) = Cx(k) - Ce^{-\lambda k}x(0) \quad (5)$$

The corresponded prediction of the sliding mode surface is

$$S_m = \{x(k) | s_m(x(k)) = 0\}$$

According to the equation (3) and the equation (5), the sliding mode function's predictive value in the future $k+p$ moment is

$$\begin{aligned} & s_m(k+p) \\ &= Cx(k+p) - Ce^{-\lambda(k+p)}x(0) \\ &= C[Ax(k+p-1) + Bu(k+p-1) \\ &\quad - Ce^{-\lambda(k+p)}x(0)] \\ &= C\{A[Cx(k+p-2) + Bu(k+p-2) + Bu(k+p-1)] \\ &\quad - Ce^{-\lambda(k+p)}x(0)\} \\ &\quad \vdots \\ &= CA^p x(k) + \sum_{i=1}^p CA^{i-1} Bu(k+p-i) - Ce^{-\lambda(k+p)}x(0) \end{aligned} \quad (6)$$

Where P can be any integers.

2.3 The design of sliding mode predictive control law

Feedback correction

This article deal with the effect of non-linear, time-variation and external disturbance using the difference between the output of the practical switching function $s(k)$ and the prediction value $s_y(k)$. For the output of the sliding mode prediction model $s_m(k+p)$ used feedback correction principle, the closed-loop output is

$$\hat{s}_m(k+p) = s_m(k+p) + h_p [s(k) - s_y(k)] \quad (7)$$

Where $h_p \in R$ is correction coefficient, $s_y(k)$ is the predictive value of moment $k-p$ to moment k .

Sliding mode reference trajectory

The reference trajectory is desired trajectory in the predictive control. The last form of the sliding mode control law is determined by the reference trajectory, there used the common exponential approach law[6] as the reference trajectory, then

$$\begin{cases} s_r(k+p) = \mu s_r(k+p-1) - \eta \text{sgn}(s_r(k+p-1)) \\ s_r(k) = s(k) \end{cases} \quad (8)$$

where $0 < \mu < 1, \eta > 0$.

Design of the control law

Considering the two factors that the change of control increment can't be large in the control process and the predictive output should be close to the desired output determined by the reference trajectory, the optimization performance index is defined as

$$J_p = \sum_{i=1}^N q_i [\hat{s}_m(k+i) - s_r(k+i)]^2 + \sum_{j=1}^M r_j [u(k+j-1)]^2 \quad (9)$$

Where N is predictive domain; M is control domain; q_i and r_i are weighted coefficient. This equation may be written as

$$\begin{aligned} J_p &= [\hat{S}_m(k+1) - S_r(k+1)]^T Q [\hat{S}_m(k+1) - S_r(k+1)] \\ &\quad + U^T(k) R U(k) \\ &= [\Phi x(k) + G U(k) - \Omega x(0) + H E(k) - S_r(k+1)]^T \\ &\quad Q [\Phi x(k) + G U(k) - \Omega x(0) + H E(k) - S_r(k+1)] \\ &\quad + U(k)^T R U(k) \end{aligned} \quad (10)$$

Parameters are as follows:

$$\begin{aligned} Q &= \text{diag}(q_1, q_2, q_3 \dots q_N), \\ R &= \text{diag}(r_1, r_2, r_3 \dots r_M), \quad H = \text{diag}(h_1, h_2, h_3 \dots h_N), \\ S_r(k+1) &= [s_r(k+1), s_r(k+2), s_r(k+3), \dots, s_r(k+N)]^T, \\ E(k) &= [s(k) - s_y(k|k-1), s(k) - s_y(k|k-2), \dots, s(k) - s_y(k|k-N)]^T, \\ U(k) &= [u(k), u(k+1), u(k+2), \dots, u(k+M-1)]^T, \\ \Phi &= \begin{bmatrix} CA \\ CA^2 \\ \vdots \\ CA^N \end{bmatrix}, \quad \Omega = \begin{bmatrix} Ce^{-\lambda(k+1)} \\ Ce^{-\lambda(k+2)} \\ \vdots \\ Ce^{-\lambda(k+N)} \end{bmatrix}, \end{aligned}$$

$$G = \begin{bmatrix} CB & 0 & \dots & \dots & 0 \\ CAB & CB & \dots & \dots & 0 \\ \vdots & \vdots & \dots & \dots & CB \\ \vdots & \vdots & \dots & \dots & \vdots \\ CA^{N-2}B & CA^{N-3}B & \dots & CA^{N-M}B & \sum_{i=0}^{N-M-1} CA^i B \\ CA^{N-1}B & CA^{N-2}B & \dots & CA^{N-M+1}B & \sum_{i=0}^{N-M} CA^i B \end{bmatrix}$$

The control law can be determined by the optimal value is

$$U(k) = (G^T Q G + R)^{-1} G^T Q [S_r(k+1) - \Phi x(k) - \Omega x(0) - H E(k)] \quad (11)$$

Using the rolling optimization in the predictive control gives the control signal of the closed-loop system that

$$u(k) = [1 \ 0 \ \dots \ 0] (G^T Q G + R)^{-1} G^T Q [S_r(k+1) - \Phi x(k) - \Omega x(0) - H E(k)] \quad (12)$$

IV. SIMULATION STUDY

Consider the following uncertain discrete-time system $x(k+1) = (A + \Delta A)x(k) + (B + \Delta B)u(k) + d(k)$

Parameters are as follows

$$\begin{aligned} A &= \begin{bmatrix} 1.2 & 0.1 \\ 0 & 0.6 \end{bmatrix}, \quad \Delta A = \begin{bmatrix} 0 & 0.1 \\ 0.3 & 0 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \quad \Delta B = \begin{bmatrix} 0 \\ 0.2 \end{bmatrix} \\ d(k) &= [0 \ 0.3 + 0.3 \sin(2\pi k / 50)]^T \\ x(0) &= [8 \ 5]^T, \quad C = [5 \ 1] \end{aligned}$$

Respectively adopting general sliding mode combined with predictive control method and the proposed method in this paper for simulation.

Predictive horizon $N=5$; Control horizon $M=2$; Control weighted coefficient $r_i=0.1$; Error weighted coefficient $q_i=2$; Feedback correction coefficient $h_i=0.5$; Commonly using the exponential reaching law as the reference trajectory, $\eta=0.01, \mu=0.6$.

The results of simulation are as follows:

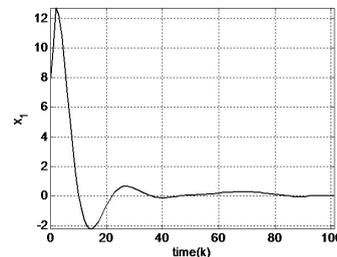


Fig.1. The state response of the combination

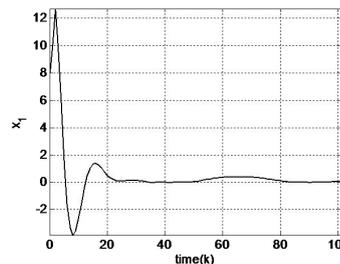


Fig.2. The state response of the combination of general sliding mode and predictive control

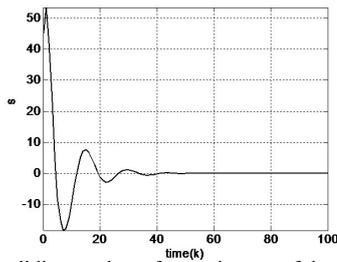


Fig.3. The sliding mode surface trajectory of the combination

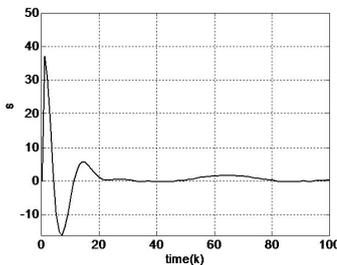


Fig.4. The sliding mode surface trajectory of the general sliding mode and predictive control combination global sliding mode and predictive control

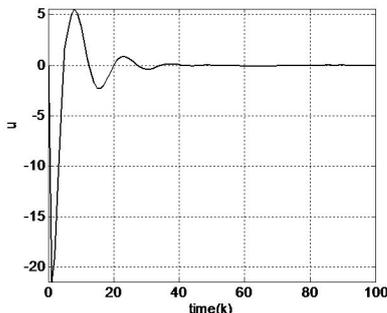


Fig.5. The control input of the combination

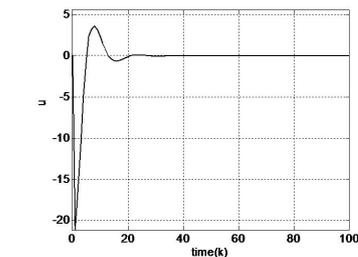


Fig.6. the control input of the combination of general sliding mode and predictive control global sliding mode and predictive control

In the case of multi-step predictive control, the results of simulation can be seen from figure 1 to figure 6. From the simulation diagram, the two algorithms can deal with the uncertainties and external disturbance of system. The system will convergence to the origin and eliminate the chattering in a period of time when the system meets with uncertainties or external disturbance. While using the control algorithm of the combination of general sliding mode and predictive control, the overshoot of the system and the amplitude of the control is larger. Using the algorithm mentioned in this paper, the state is in the sliding mode surface since the beginning and has strong robustness in the whole process of response. By comparison, the arrival time has been significantly reduced.

V. CONCLUSION

The global sliding mode variable structure control algorithm based on predictive control strategy proposed in this paper, considering the indexes of chattering, arrival time, robustness and so on. The controller designed makes the state of the system in the sliding mode surface at the beginning, eliminates the arrival time and depends on the feedback correction and rolling optimization in the predictive control to deal with the uncertainties and external disturbance, makes the system has complete robustness.

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Study on Options Valuation of Civilian Airport Infrastructure Based on Computer Simulation

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Abstract— In this paper, we proposed that environmental uncertainty and government guarantee of the civilian airport can increase the project option value. First, the author obtained the optimal probability under individual Knight’s uncertainty, and established the minimum pricing model with random volatility on this probability measure, deriving the minimum pricing formula of European call option with Knight aversion. Second, the author considered that restricted competition is the most type of government guarantee, and used MATLAB simulation calculated the impact of restricted competition on the project value by mathematical model. In addition, a case of value options of the Hongqiao business jet was studied in order to prove the formula.

Index Terms—civil airports; infrastructure; Knight’s uncertainty; option pricing with stochastic volatility; restricted competition; MATLAB simulation

I. INTRODUCTION

The greatest concern for the investors of civilian airport infrastructure, is to be able to achieve the expected economic benefits. According to the traditional decision method of cash flow, when the internal rate of return on an investment project is greater than the benchmark discount rate[1], policymakers should invest right away. Cash flow in the actual operational period, however, may be inconsistent with the forecasted cash flow. When the actual value is lower than the predicted value, the original decision might lead to errors. The investment may be difficult to recover or the recovery period will be extended. from the view of the options. In addition to in the value of the project that is based on the time value under traditional decision-making methods, the project also includes a flexible value from project management as well as the value of uncertainty information (i.e., flexibility value of management)[2]. The value of the project equals to the present value of cash inflows and the project flexibility value[3]. Traditional decision-making methods assumes that the asset value of the investment projects will be reduced with the increased uncertainty and real options theory accounts that uncertainty will increase the value of the project if managers can make effective business decisions[4]. Civilian airport infrastructure investment has a huge one-time investment and a long payback period. Accordingly, project uncertainty must be fully considered, including market uncertainty, and the uncertainty of the construction costs[5].

II. OPTIONS PRICING MODELS

Previous reports in the literature have only considered market visits when it involves risks and does not contain Knight’s uncertainty. However, Knight’s uncertainty of the real market cannot be ignored. Han and Pan treated random volatility of option pricing problems from the perspective of Knight’s uncertainty, and they first proved

that the immediate volatility model is essentially a problem of Knight’s uncertainty. They used discounted relative entropy to measure Knight’s uncertainty, then balanced Knight’s uncertainty and Knight premium through a utility function, and got the optimum probability measure and the price formula of the European call option with the Knight aversion degree. Zhang studied financial markets with Knight’s uncertainty, and assumed the underlying stock asset follows geometric Brownian motion, where the models of minimal pricing of European stock options are made. Moreover, the explicit solutions of the models were given by using the theories of a backward stochastic differential equation. The European call option with a stochastic volatility model based on Knight’s uncertainty first proves that the stochastic volatility model can be converted to Knight’s uncertainty model. The model also assumes that based on Knight’s uncertainty, the individual introduces ‘premium Knight – the Knight uncertain utility’ function to handle Knight’s uncertainty. In the utility function, individuals weigh Knight’s uncertainty to make the optimal choice. However, Knight’s uncertainty in the model does not consider objectivity and utility functions of individuals are set to ‘rational economic man’. Simon’s theory holds that the decision-making is impossible for realizing the principle of the optimization. The minimum pricing model is able to compensate for this deficiency. The minimum pricing model and option pricing with stochastic volatility are based on the financial market prices, and this paper will apply the financial model to the real options model.

A. European options minimum pricing models

Space (Ω, F, P) is a probability space, $\{F_t\}_{0 \leq t \leq T}$ is the domain generated by the one-dimensional standard Brownian motion, which meets the usual assumptions (completeness, monotonically increasing, right-continuous), converts $F = F_t$. If one trading assets on the market is a risk-free bond, whose interest rate is constant r , another stock should meet their price formulas (1) and (2):

$$dP_t = P_t r dt, \quad P_0 = 1 \tag{1}$$

$$dS_t = S_t (\mu dt + \sigma dB_t), \quad S_0 = s \tag{2}$$

r, μ, σ, s are constants. The following formulas can be obtained from formulas (1) and (2),

$$S_t = s \exp \left\{ \left(r - \frac{1}{2} \sigma^2 \right) t + \sigma B_t^\varrho \right\}, \quad 0 \leq t \leq T \tag{3}$$

With respect to formula (3), $B_t^\varrho = \sigma^{-1}(\mu - r)t + B_t$,

$$\text{make } \tau = \sigma^{-1}(\mu - r), \quad \frac{dQ}{dP} = \exp \left\{ -\tau B_t - \frac{1}{2} \tau^2 T \right\}$$

From the Girsanov theory, it is known that Q and P are equivalent probability measures, and $\{B_t^\varrho\}_{0 \leq t \leq T}$ follows the Brownian motion.

For European options, the maturity date T , and exercise price K of the call option is employed as follows:

$(S_T - K)^+ = \max(S_T - K, 0)$. In order to portray Knight uncertainty on the financial markets, a viable control

collection is introduced: $\Theta = \{(\theta_t)_{0 \leq t \leq T} \mid |\theta| \leq k, a.e.t \in [0, T]\}$, $k > 0$, Which is called Θ K-ignorance, an equivalent probability measure generated by the collection of Θ :

$$\wp^\theta = \left\{ Q^\theta \left| \frac{dQ^\theta}{dQ} = \exp \left[-\int_0^T \theta_s dB_s - \frac{1}{2} \int_0^T \theta_s^2 ds \right], (\theta_s)_{0 \leq s \leq T} \in \Theta \right. \right\}$$

Knight uncertainty on the financial market is usually portrayed by the collection \wp^θ , and investors do not know which probability measure should be used in the European option pricing. From a conservative point, investors will give the minimum pricing to European options,

$$C(S_T, K) = \min_{Q^\theta \in \wp^\theta} \left\{ E^{Q^\theta} \left[e^{-rT} (S_T - K)^+ \right] \right\} \quad (4)$$

Uniqueness of solution for formula (4) can be proved by the following two lemmas:

Lemma1 respectively exists $(\theta^1)_{0 \leq t \leq T} \in \Theta$, which meet

$$C(S_T, K) = E^{Q^{\theta^1}} \left[e^{-rT} (S_T - K)^+ \right] \quad (5)$$

The proof sees literature 6.

Lemma2 suppose the diffusion coefficient $\sigma > 0$ in the stock price equation (2), in lemma 1, $(\theta^1)_{0 \leq t \leq T} \equiv k$, $(\theta^2)_{0 \leq t \leq T} \equiv -k$, therefore,

$$C(S_T, K) = E^{Q^{(k)}} \left[e^{-rT} (S_T - K)^+ \right] \quad (6)$$

From formula (6), we can write $\frac{dQ^{(k)}}{dQ} = \exp \left\{ -k B_T - \frac{1}{2} k^2 T \right\}$.

Theorem suppose the diffusion coefficient $\sigma > 0$ in the stock price equation (2), then

$$C(S_T, K) = S e^{-k\sigma T} N(d_1) - K e^{-rT} N(d_2) \quad (7)$$

$$d_1 = d_2 + \sigma \sqrt{T}$$

From formula (7), we can

$$\text{write } d_2 = \frac{\ln \frac{S}{K} + (r - k\sigma - \frac{1}{2} \sigma^2) T}{\sigma \sqrt{T}}$$

Formula (7) is the minimum pricing model of European option under Knight's uncertainty environment.

B. Stochastic Volatility Option Model

This section assumes that the model is built from risk-neutral conditions, and it is further assumed that r is the fixed risk-free interest rate in a risk neutral probability measure P , α and β are constants, assuming the Wiener process $dB(t)$ and $dW(t)$ are independent from each other.

The underlying asset follows the following procedure:

$$dS(t) / S(t) = rdt + \sigma(t)dB(t) \quad (8)$$

$$d\sigma(t) / \sigma(t) = \alpha dt + \beta dW(t) \quad (9)$$

From formula (9), an expression for the instantaneous volatility can be written as:

$$\sigma(t) = \sigma(0) \exp \left[\left(\alpha - \frac{\beta^2}{2} \right) t + \beta W(t) \right] \quad (10)$$

suppose $h(t) = \exp \left[\left(\alpha - \frac{\beta^2}{2} \right) t \right]$, $X(t) = \exp[\beta W(t)]$, then

a new process can be written as:

$$dS(t) / S(t) = rdt + \sigma(0)h(t)X(t)dB(t) \quad (11)$$

If we consider the following deterministic time-varying volatility, then volatility becomes a non-random and deterministic process that changes over time:

$$dS(t) / S(t) = rdt + \sigma(0)h(t)d\tilde{B}(t) \quad (12)$$

Because $X(t)$ and $dB(t)$ are independent, at the moment t , $X(t)dB(t)$ can be handled by two steps. First

of all, according to the distribution of $X(t)$, $x(t)$ can be randomly selected, then we can result in a random process with deterministic time-varying volatility that is similar to formula (12).

$$dS(t) / S(t) = rdt + \sigma(0)h(t)x(t)dB(t) \quad (13)$$

The value of $x(t)$ in formula (13) has unlimited possibilities.

A different random process with different deterministic time-varying volatility can be obtained from different $x(t)$, when individuals face formula (11), He or She actually faces a family with random process in formula (13), in the face of possible probability distributions of $S(t)$. In fact, the individual is actually facing a Knight's uncertainty problem, according to the thought of Bewley that the individual selects the reference model based on the 'inertia', 'belief', 'status quo'. Han assumed that individuals choose a conservative probability measure that is based on an average estimate, and individuals know their choice of the reference model is not accurate. By disturbing the probability measure P , the probability measure \tilde{P} can be obtained, and by the utility function $V(P)$, the individual selects an optimal measure P^* . A reference model can be selected with the following characteristics:

$$D[x(t)dB(t)] = D[X(t)dB(t)]$$

Suppose $x(t) = e^{\beta t}$, the reference probability measure can be obtained under probability measure P ,

$$dS(t) / S(t) = rdt + \sigma(0)h(t)e^{\beta t}dB(t) \quad (14)$$

for the individual, formula (14) may be a conservative estimate. The reference model is not precise enough, and there may be another probability measure. If $m(t) = dP / dP$, $m(t)$ is a Radon-Nikodym derivative of \tilde{P} to P , then the expression of $m(t)$ can be written as follows:

$$m(t) = \exp \left[\int_0^t \theta(t)dB(t) - \frac{1}{2} \int_0^t \theta^2(t)dt \right] \quad (15)$$

With respect to formula (15) (suppose it is a non-random process), the following formula is satisfied:

$$E \left\{ \exp \left[\int_0^t \theta^2(t)dt \right] \right\} < \infty \quad (16)$$

Also, the following formula can be obtained under the reference probability measure P ,

$$dS(t) / S(t) = (r + \sigma(0)h(t)\theta(t)e^{\beta t})dt + \sigma(0)h(t)e^{\beta t}dB(t) \quad (17)$$

From formula (17), the premium $\pi(t) = \sigma(0)h(t)\theta(t)e^{\beta t}$ is generated due to the deviation from the model reference probability measure P . A 'premium Knight - Knight's uncertainty' based utility function $V(P)$ is introduced to solve the Knight's uncertainty model, defined as:

$$V(P) = K(P) - \gamma R(P) \quad (18)$$

Among formula(18), $K(P)$ is a premium under probability measure P , $R(P)$ represents uncertainty, and $\gamma > 0$ represents Knight aversion. The individual has to select appropriate risk neutral probability that makes the utility function $V(P)$ maximum. Assuming the discount factor is $e^{-\delta t}$, and then the cumulative discounted Knight premium is $K(P)$:

$$K(P) = \int_0^\infty e^{-\delta t} \pi(t)dt = \int_0^\infty e^{-\delta t} \sigma(0)h(t)e^{\beta t} dt \quad (19)$$

$$R(P) = 1/2E \left[\int_0^{\infty} e^{-\delta t} \theta^*(t) dt \right] \tag{20}$$

$$\theta^*(t) = \frac{\sigma(0)}{\gamma} e^{(\alpha + \frac{1}{2}\beta^2)t} \tag{21}$$

Assume that formulas (19) and (20) and the Euler equation shows: From formulas (17) and (21), the price of the underlying asset is obtained following the process probability measure:

$$dS(t) / S(t) = (r + \frac{\sigma^2(0)}{\gamma} e^{(2\alpha + \beta^2)t}) dt + \sigma(0) e^{(\alpha + \frac{1}{2}\beta^2)t} dB^*(t) \tag{22}$$

in order to obtain European option prices for the underlying assets following formula (22), according to Shreve's argument, assume that the underlying asset European call option price for the first time under the risk-neutral conditions is as follows:

$$C(T, S(0)) = BSM \left\{ T, S(0), K, \frac{1}{T} \int_0^T \bar{r}(t) dt, \sqrt{\frac{1}{T} \int_0^T \sigma^2(t) dt} \right\} \tag{23}$$

In formula (23), $BSM(S, K, \bar{r}, \bar{\sigma})$ is the price of a standard European call option, the initial underlying asset price is S , exercise price is K , \bar{r} is unchanged interest rate, and $\bar{\sigma}$ is unchanged volatility.

C. European minimum options

By Shreve's argument and European options pricing formula in section 2.2.2, the European call option formula with random volatility of the underlying asset at the initial time can be obtained:

$$C^*(T, S(0), K) = BSM(T, S(0), K, \bar{r}, \bar{\sigma}) = S e^{-k\sigma T} N(d_1) - K e^{-rT} N(d_2)$$

From the above formula, we can write:

$$\bar{r}^* = r + \frac{\sigma^2(0)}{T\gamma(2\alpha + \beta^2)} \left[e^{(2\alpha + \beta^2)T} - 1 \right] \tag{24}$$

$$\bar{\sigma}^* = \sqrt{\frac{\sigma^2(0)}{T(2\alpha + \beta^2)} \left[e^{(2\alpha + \beta^2)T} - 1 \right]} \tag{25}$$

- S ---- the price of the underlying asset,
- K ---- the cost of the underlying asset investment,
- σ ---- volatility of Asset value,
- T ---- option exercise time,
- k ---- the parameter of Knight's uncertainty,
- γ ---- knight Aversion.

III. CASE STUDIES

A. Project Description

In Shanghai, October 2006, Shanghai Airport Authority and Australia's Hawker Pacific Business Aviation Development Co., Ltd., which makes the Shanghai business jet base project, signed a memorandum of cooperation and entered into a substantive start-up phase. The total investment of the joint venture is 175 million yuan, and the registered capital is 120 million yuan. The Airport Group invested 61.2 million yuan, accounting for 51%, and Hawke companies invested 58.8 million yuan, accounting for 49%. According to the estimate of the feasibility study report, a one-time payment of all ground facilities lease costs and 50% of the land lease costs, the part of the rent totaling approximately 1.0255 billion; and additional 50% of the land lease fee costs 53 million yuan in 20 years, which totally accumulates to approximately 1 billion. The joint venture awarded Hawke the right to operate in Shanghai Airport and engage in the business jet terminal building and apron services. A one-time rental income equal to the total cost of the construction,

and 5% of the revenue each year pays for the franchise fee. In the calculation process, a one-time rental 1.0255 billion of the joint venture company was thought as the investment of the project, and the other 50% of the rental fee as operating costs allocated to 20 years' payment. According to the traditional cash flow evaluation methods, long-term bonds yielding a risk-free interest rate of 6.15% were made. An investment net present value (NPV) of Shanghai Hongqiao business jet base is 22.8293 million yuan. From the view of traditional investment decision-making theory, $NPV > 0$, the investment project can be launched, but the rate of return is similar to the risk-free rate. Therefore, for investors, this is not very attractive. Moreover, the operating cycle of the project is up to 21 years. For investment projects, there are many risk factors, but if investors take into account fluctuations of the PPP (Public-Private-Partnership) project cash flow into consideration, then the investment value of the project may not be so low. Herein, we re-evaluate the value of the project based on the minimum pricing models with the Knight's uncertainty stochastic volatility.

B. Industry Knight uncertainty

THE GENERAL AVIATION INDUSTRY IS AN EMERGING INDUSTRY IN CHINA, WHICH MAINLY REFERS TO AVIATION ACTIVITIES IN ADDITION TO MILITARY, POLICE, AND CUSTOMS OFFICIALS. EXCEPT FOR AIR TRANSPORT FLIGHT AVIATION ACTIVITIES, OTHER MAJOR INDUSTRIES INCLUDE: AGRICULTURE, FORESTRY, FISHERIES, MINING, CONSTRUCTION AND FLIGHT OPERATIONS AND HEALTH, DISASTER RELIEF, METEOROLOGICAL EXPLORATION, MARINE MONITORING, SCIENTIFIC RESEARCH, REMOTE SENSING, MAPPING, EDUCATION AND TRAINING, CULTURE, SPORTS, AND TOURISM. BUSINESS AVIATION, ALONG WITH ECONOMIC DEVELOPMENT, IS THE FASTEST GROWING AND MOST IMPORTANT INDUSTRY - IN GENERAL AVIATION. THERE ARE MANY PROBLEMS IN THE DEVELOPMENT OF CHINA'S BUSINESS JET INDUSTRY. THE ENVIRONMENT OF THE INDUSTRY HAS A HIGH DEGREE OF UNCERTAINTY. USING THE ANALYTIC HIERARCHY PROCESS, AND THE AUTHOR HAS VISITED THE AIRPORT FIVE EXPERTS AND OBTAINED A KNIGHT'S UNCERTAINTY = 0.74 (TABLE.1).

C. THE DETERMINATION OF OPTION VALUE

In order to estimate the civilian airport industry with Knight aversion, we first need to estimate the parameters of the stochastic volatility models (1) and (2), and then generate the analog data of a structural model. There are many methods of parameter estimation, such as the estimation method of moments, the method of least squares, the Bayesian estimation method and the maximum likelihood estimation method, etc. Here, the author uses the simulation based technique Efficient Method of Moments (EMM) put forward by Gallant and Tauchen to estimate the parameters of the stochastic volatility model. The basic idea is based on the analog technology moments matching process, using the score of the auxiliary model as the moment conditions in the structural model of expectations. The auxiliary model chosen by the EMM estimation method should be approximated to the real structure model, and the dimension of the vector of the auxiliary parameters of the model must be greater than or equal to the dimension of the vector of the estimated model parameters of the real structure. First, according to the listing date and the exercise start date that Hawker Pacific company subscribes, select the appropriate trading day (20/08/2011---18/08/2012) of the underlying securities and the closing price is estimated by EMM. From the results of EMM estimates, it can be seen that the value of b is close to 1 (Table.2, Table.3). Second, utilizing the

least squares method (LSM) involves the following minimizing the square of the error and finding data that matches the best function, fitting the closing price of a range HP company, the author estimates γ , the exercise price is 1.04, the exercise ratio is 1, fitting time interval is from July 21, 2012 to August 17, 2012, for the 28 trading days, the author checks that the SHIBOR interest rate of the corresponding one-year time interval is 0.0315. Setting the trading day at 252 days, it is available to estimate $\alpha = -0.174$, $\beta = 0.113$. α, β is substituted into formula (24), using the LSM fitting warrants data, and here we derive that $\gamma = 0.351$.

D. Option value

The following data can be obtained from the Statement of Cash Flows: (Unit: million)

So, if the present value is 12,528 million, then the author makes a five-year long-term treasury bill rate as the risk-free rate $r = 6.15\%$. It is known that, $r^* = 8.66\%$, $\sigma^* = 9.38\%$
 $\sigma(0) = 0.249$, $\alpha = -0.174$, $\beta = 0.113$, $T = 21$,

$$\begin{cases} d_2 = \frac{\ln(\frac{S}{I}) + (r - k\sigma - \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}} \\ d_1 = d_2 + \sigma\sqrt{T} \end{cases}$$

Therefore, the following result can be obtained:

$$\begin{aligned} d_2 &= 1.09, d_1 = 1.52, \\ C &= 12538 \times 0.261 \times N(1.52) - 10255 \times 0.169 \times N(1.09) \\ &= 1497 \text{ (unit: million)} \end{aligned}$$

IV. GOVERNMENT GUARANTEE

Both the developed and developing countries actively explore their own infrastructure construction plan^[7]. In order to further strengthen the capacity of infrastructure supply and make up long-term serious shortage situations of investing in the construction of infrastructure finance only by government funding and government loans, the trend that the government is a guarantee people become more and more popular, the government guarantee in infrastructure projects is different from general government guarantee, which refers to the government action which gives preferential policies or guarantee on franchise business, investment return and environment conditions in order to attract non-government investors to invest in the infrastructure construction^[8]. The government guarantees means that the government must compensate to the secured party when the secured party's income is lower than the set guarantee, and the secured party are either private investors or financial institutions. Using the PPP financing model in public infrastructure projects, the important role of the government guarantee has gained more and more attention (Table.4). Restricted competition is more common in the civil airport industry, when aircraft movements are greater than a set value^[9]. The Government has the right to build in the same geographical range as the second business jet base. When aircraft movements are greater than the highest limit, the second home business jet base has the right to start operations. Additionally, the original business jet base often maintains a competitive advantage in the operating period, that is embodied in the mathematical model, which means additional revenue should be extracted by the government^[10]. This is as shown by the following formula:

$$SF_i = \begin{cases} 0, & \text{if } Q_i^R \leq Q_i^C, \\ (Q_i^R - Q_i^C) \cdot P_i \cdot w & \text{if } Q_i^R \geq Q_i^C \end{cases} \quad (26)$$

Here, we report the impact of the restriction competition on project value under the initial aircraft movements, aircraft movement's growth rate and other factors based on the Charles (2005) model. Investors have a call option. The benchmark rate of return is 7.15%, according to the feasibility study report. The calculation steps are as follows: (1) Determine the probability distribution of the initial business jet movements, the probability distribution of the growth rate of aircraft movements and the probability distribution of the annual aircraft movement's income. (2) Based on the above parameters, we have simulated the distribution path of aircraft movements in the period of the concession. (3) In each path, when the condition is triggered, the condition of call options is set by the government guarantee. Additionally, the government revenue is calculated, and here we calculate the government revenue on each path. (4) To simulate multiple paths, and calculate the statistical value of government revenue.

Table.1
Auxiliary model parameter maximum likelihood estimation results.

| Variable | Estimate | Standard Error | t value | Approx p |
|----------|----------|----------------|---------|----------|
| a | 0.0067 | 0.000721 | 4.21 | <.0001 |
| b | 0.1371 | 0.00038 | 13.47 | <.0001 |
| c | 0.8249 | 0.00266 | 83.14 | <.0001 |

The theoretical value of the initial jets taking off and landing have an important impact on the economic benefits of the official machine base. Although, estimating the official initial machine movements of the jet base is difficult, here we make an estimate of the official initial movements in feasibility report for numerical calculation (Table.5).

Table.2
EMM parameter estimation results.

| Variable | Estimate | Standard Error | t value | Approx P |
|----------|----------|----------------|---------|----------|
| a | 0.01764 | 0.000536 | 40.82 | <.0001 |
| b | 0.97864 | 0.000427 | 2325.64 | <.0001 |
| c | 0.19659 | 0.00026 | 185.46 | <.0001 |

With respect to the movements estimation, and according to the 'feasibility study report of S jet base', the growth rate of official machine movements changes along with time.

Table.3
Probability distribution of the official machines with initial movements

| Variable | Distribution | Mean | Growth Rate | Standard Deviation |
|-----------------------|----------------------------|--|-------------|--------------------|
| The initial movements | The lognormal distribution | movements of the first year in operation years | 0 | 14% |

Due to the project construction and early operation time, which is an important stage for official machine development, in the first stage, growth rate reached 15%. After the year 2017, the construction of official machine projects goes into operation in China, although these bases are far away from each other in geographic space. However, they have a certain influence on the project, so the growth rate will drop to 10%, after the year 2025, and the growth of official machine movements will go into the stable stage because of the project design capacity.

The jet base income cannot be directly calculated through the car goods flow as well as air cargo station or highway project. The income of the official machine base

is divided into three parts. Firstly, the income of FBO (Fixed Base Operator), in which the revenue of this part

Table.4 The growth of business jet movements

| Operating years | mean | Standard deviation |
|-----------------|------|--------------------|
| 2009-2016 | 14% | 11.4% |
| 2017-2024 | 8% | 6.45% |
| 2025-2029 | 1% | 1.74% |

includes parking service, channel service, ground service and agency services. All kinds of income from services can be calculated by a public frame time multiplied by the service rate. However, the volume of four different business services is often different, and the most basic service is the stopping service and channel service. When the development of these two kinds of service becomes mature, it can drive the development of ground services and agency services. Secondly, the income of MBO (Maintenance Base Operator). The revenue and income of this part includes repair income, spare parts sales income, subcontracting income and warehouse management income. Thirdly, management and charter income. This can be divided into small, medium and large machine charters. The parameters calculated in Table.5 are based on parking services, in which other services can be regarded as the extension of the parking services and ancillary revenue services. During the operational period, the same number of parking services brings about different service incomes, which is due to the different stages of development. In general, in the initial stage of development, aircraft parking services brings about a low income. However, during the development of the later operational stages, due to the rich service content and improved quality, aircraft income will increase, which is brought about by parking service. To a certain extent, income caused by each aircraft is fixed at a certain level, but the operating costs will rise because of various factors.

In the case of restricting competition, according to the government contract pumping ratio (0.4) and government restriction on competition ratio (1.3), the government revenue is 9.2881 million yuan (Figure.1). If the government contract pumping ratio and government restrictions on competition ratio changes, the government revenue will change correspondingly (Table.5).

Under the restricting competition (see Figure.2), the relationship is simulated on MATLAB platform between the three factors, including restricting proportion, and the proportion of shared government income. It can be seen that the government guarantees or incomes increase with the rise of shared percentage, while these decrease with the increase of the competition restriction ratio. In practice, the government and investors can negotiate the percentage of shared and restricted competition according to their strengths. This depends on the project environment and their attitudes to risk.

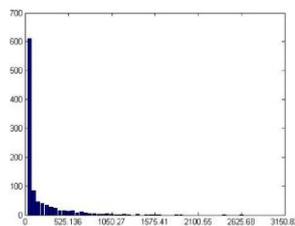


Fig.1. Government revenue under restricted competition

Table.5 Simulation results of government revenue under restricted competition

| Statistics | Simulation Times | Mean | Standard Deviation |
|------------|------------------|--------|--------------------|
| Numerical | 1000 | 928.81 | 61579 |

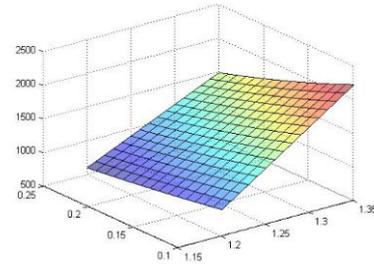


Fig.2 The relationship of income pumping proportion with the restricted competition proportion

V. CONCLUSION

The topic of the real options method investment is on the forefront of academic research in the field of decision-making in the current project. Theorists on the real options approach paper was discussed more, but less was discussed regarding the enterprise application level. In this paper, the author used the Hongqiao business jet base case to prove option pricing in the enterprise and MATLAB simulation to calculate the impact of restricted competition on the project value by mathematical model.

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Research on the Target Feature Recognition and Simulation Based on Gene Expression Programming

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Abstract—In this paper, We studied the gene expression programming, on the analysis of the structure of gene expression trees, finally, the target feature recognition based on gene expression programming experiment and simulation. The results show that the GEP algorithm for identification of unknown nonlinear systems is feasible.

Index Terms—Gene expression programming, Target feature, Gene expression trees, Nonlinear systems.

I. INTRODUCTION

Gene Expression Programming (Gene Expression Programming, referred to as GEP) is a kind of comprehensive evolved by genetic algorithms and genetic Programming of evolutionary algorithm. GEP is Portugal scholar Candida Ferreira first proposed in 2001 based on genotype and phenotype of new adaptive evolutionary algorithm [1], it simulates biological evolution process to optimize problem solving, innovative put forward of mutual transformation between genotype and phenotype is separated and model. Gene expression programming is a combination of genetic programming and genetic algorithm, the advantages of using simple compact isometric linear symbol as the genetic encoding, using nonlinear expression tree as an individual phenotype, has a strong ability to solve practical problems [2, 3].

II. GENE EXPRESSION PROGRAMMING PRINCIPLE AND STRUCTURE

GEP genetic operation is the basic unit of chromosomes, the genetic information carrier is the smallest unit of genes, the header and tail. Head for endpoint Set of symbols (Terminal Set. The shorthand for T) of the element, can also be a Set of functions, the Function Set, Simple as the symbol F) of the element, and the tail element can only limit in the endpoint Set (terminals). When application of GEP algorithm for classification, the first generating initial population. Everyone in the population USES a hierarchy variable expression trees to represent the nodes of the tree by the endpoint set T and function set elements of F. The end point set is composed of the most basic element such as constants and variables set. Function set is meet the endpoints closed connection operator, mainly include the arithmetic operators, the standard mathematical functions,

conditional expression and logical operators can be defined mathematical functions, etc. .

Such as formula (1) the function of endpoints define as $\{x, y, z\}$, function sets $\{*, /, -, \cos\}$:

$$f(x, y, z) = (x * y) / z - \cos(y) \quad (1)$$

Formula (1) in the function of expression tree as shown in figure 1:

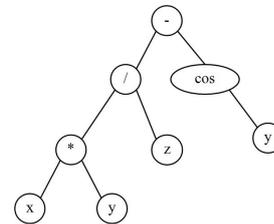


Figure 1 Function $f(x, y, z)$ expression trees.

Head length h is selected according to specific problems B_0 , tail length is a function of h and n . N for GEP gene contains functions focusing all the maximum number of operation orders, is based on the relationship between t and h : $t = h * (n - 1) + 1$. Because of the special relationship between the head and tail, GEP gene under the action of any genetic operators will not produce syntactically incorrect individuals, to ensure the effectiveness of the genetic code, making chromosome can always decoding into effective expression trees.

In the GEP, genotype entity that evolution is a chromosome. Chromosome is actually connected operator connected with multiple genes. The phenotype in GEP is Expression Tree (Expression Tree, ET), it can between genotypes and reciprocal transformation through simple encoding and decoding rules [4, 5].

III. TARGET FEATURE RECOGNITION BASED ON GENE EXPRESSION PROGRAMMING IDENTIFICATION EXPERIMENT

By setting the GEP terminators set $\{\text{angle, RCS, ?}\}$, function set $\{+, -, *, /, \cosine, \text{sine, exp, log}\}$, using the optimal hybrid particle swarm GEP algorithm, Fitness function selection Fitness function of absolute value of deviations (when it is 0, which indicates that match the best target values and predicted values), and after the operations of the experimental data of the table I end up with:

$$RCS = 19.3866 * \cos(4.45552 - 4.04601 * \text{angle}) - 8.82378 * \text{angle} * \cos(4.04853 - 3.84653 * \text{angle})$$

Table I shown the GEP identify a flying target RCS and Angle (radians) of the relationship between the experimental data.

TABLE I.

The GEP identify a flying target RCS and Angle (radians) of the relationship between the experimental data

| angle | RCS | angle | RCS |
|-------|---------|-------|--------|
| 0.000 | -6.659 | 2.919 | -8.310 |
| 0.032 | -7.224 | 2.951 | -6.163 |
| 0.063 | -10.307 | 2.983 | -8.805 |
| 0.095 | -10.224 | 3.015 | -4.983 |
| 0.127 | -11.655 | 3.046 | -4.660 |
| 0.159 | -16.407 | 3.078 | -5.664 |
| 0.190 | -14.649 | 3.110 | -3.711 |
| ... | ... | 3.142 | -2.547 |

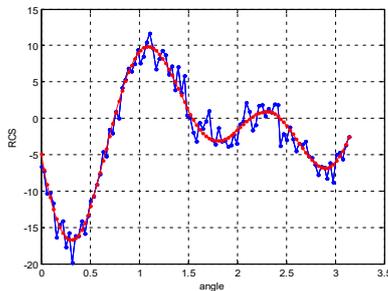


Figure 2 With identification of GEP target RCS and the Angle of the relationship between a flight.

Here the Fitness = 0.189976, using the algorithm can identify the target RCS and the Angle of the relationship between a flight. On this basis, the target characteristics

of the flying target can be real-time simulation. At the same time, it also indicates the GEP algorithm for unknown nonlinear system identification is feasible.

IV. CONCLUSION

In this paper, the nonlinear system identification experiment was carried out, the result shows the GEP algorithm for nonlinear system can effectively identify. Hybrid GEP algorithm has good numerical stability, deficiency is constant optimization algorithm are introduced to make the calculation consumption increase. Under the condition of real-time demand is not high hybrid GEP algorithm can be used to increase the performance of GEP.

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The Security Technology and Its Practical Exploration of the Digital Library Computer Network

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Abstract—The aim of this paper is at the analysis of the security and its practice methods of the digital library computer network. Taking into consideration the present security problems in the utilization of the digital library computer network and with the research in the protection methods of the corresponding network communication, this paper, by employing the mathematical statistic analysis and probability theory, is to study how to solve the cyber security problem in computer communication. Due to the complexity of the digital library computer network, the study on how the problem in the digital library computer network can be successfully solved and how the information of the users using the digital library computer network are to be prevented from malicious infringement, has gradually become one of the focus problems of the social studies.

Index Terms—The digital library, computer network, security technology, practical exploration

I. INTRODUCTION

The human society has stepped into the information age. The application range of the computer network being gradually expanded, the computer network has, consistent with it, become an indispensable part of people's life, which serves as the background for the gradually increasing attention to the computer communication information security issue in the whole society. And meanwhile, the import of the digital technology, in the process of the library management, has proved to be one of the future development trends in library management, according to which this paper, by combining the relevant computer network security management technology, is to expound how to effectively cope with network security problem in computer management^[1-3].

II. THE SECURITY TECHNOLOGY AND PRACTICAL THEORY ANALYSIS OF THE DIGITAL LIBRARY COMPUTER NETWORK

In the process of applying the security technology into the digital library computer network, it should be constructed in each link during its application, in which the advantage of the security technology applied to it is to be fully taken, so as to constantly ameliorate the application of the security technology of it, thus efficiently improving its security. And in its management process, the relevant statistic theory and probability theory are utilized in the examination work of the relevant security technology application in the digital library computer network, whose application level is exalted. The corresponding planning and design is carried out according to Figure1, demonstrating the assumption diagram of the present security management in the digital library computer network^[4,5].

The current researches on the security technology of the digital library computer network put their focus on the

effect test of the security technology in the digital library computer network, the methods employed including: the orthogonal test method (the relevant tests being carried out mainly through the establishment of the orthogonal test table), mathematical model analysis method (the analytic study being carried out mainly through the establishment of the mathematical models), normal distribution analysis method etc. Theoretical guidance for further researches can be formed through the theoretical analysis of the computer network, therefore furthering the application effect of the security technology in the digital library computer network^[6,7].

III. THE OVERVIEW OF THE SECURITY TECHNOLOGY APPLIED TO THE DIGITAL LIBRARY COMPUTER NETWORK

Although the rapid development has so far been achieved in the computer network management technology and library information management technology, yet the digital library computer network, in the application process of its security technology, is mainly demonstrated from the aspects followed^[8]:

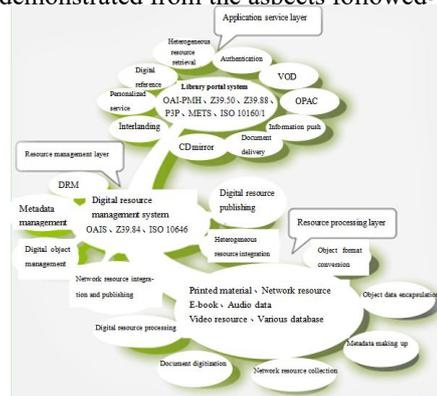


Figure 1 The Assumption Diagram of the Present Security Management in the Digital Library Computer Network

A. Solving the Problem of Being Vulnerable to Cyber Hackers

The development of the computer network technology has brought about various new work areas in the social sphere, but as every coin has two sides, the computer network technology is a double-edged sword as well; for instance, the attacks from the hackers on the computer network is highly probable in the application process of the security technology in the digital library computer network, giving rise to failure of the computer information management process. The relevant analytical tests through the normal distribution function reveal that the attacks from the computer network are likely to greatly disturb the process of applying the security technology to the digital library computer network. The normal distribution function is as follows:

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right). \quad (1)$$

Specifically speaking, the viral substances produced from the hackers' attacks(the major way being the corresponding Trojan horses produced through the programming by the hackers, for example, the " xiongmaoshaoxing" virus arising in recent years) are powerful enough to destroy the computer. In the meantime, the large circle formed by the global computers through the Internet contributes to such formidable contagion ability of the viruses prescribed by the hackers as to be capable of tremendous harm to the computer network. The computers attacked by those viruses are prone to failure in operation and leakage of data information, grievously threatening the information safety in the digital library computer network.



Figure 2 Major Types of Trojan Horses

B. Solving the Problem of the Attacks by the Trojan Horses

Up to now, the most widespread virus on the Internet has been the Trojan horses, which may probably launch the attack during the application of the security to the digital library computer network. Figure2 has listed the major types of Trojan horses for the moment.

To be specific, the current Internet web pages are replete with Trojan horse programs(for example, various network connections being highly probably encompassed with substantial Trojan horses). If the security technology users, in the process of network query, activate the Trojan horse programs on the corresponding network connection, only by an accidental click on it, those programs are likely to be downloaded into the digital library computer network, where they are accelerated in a considerable rate, causing great harm to the digital library computer network and thus threatening the information safety of that. In analyzing the application of the security technology to overcoming the attacks from the Trojan horse programs, the probability of being attacked may be known to carry out the corresponding test analysis. In the process, the F test method:

$$F = \frac{n_1^{\frac{n_1}{2}} n_2^{\frac{n_2}{2}} \Gamma\left(\frac{n_1+n_2}{2}\right) x^{\frac{n_1}{2}-1}}{\Gamma\left(\frac{n_1}{2}\right) \Gamma\left(\frac{n_2}{2}\right) (n_1 x + n_2)^{\frac{n_1+n_2}{2}}}, \quad (2)$$

is mainly utilized in the verification and analysis of the pertinent statistics, in order to find an efficient tactic to smash the programs' attacks, hence perfecting the application effects of the security technology in the digital library computer network.

C. Solving the Problem of Protecting the Information of the Digital Library Computer Network

The majority of the computer users do not have the professional programming skills, with a lack of the information security awareness of the digital library computer network as well, although most of them are capable of basic computer operation skills. The above-mentioned serving as the milieu, the users of the digital

library computer network, in the operation process, are vulnerable to their own misoperation. Concretely, leaking the information of the digital library computer network on the Internet due to the users' ignoring the protection of their secret information, is to blame for the Internet security issues, this seriously infringing the users' information safety.

Meanwhile, the digital library computer network, being a novelty, is quite an intricate system (covering numerous programming technology and cloud storage technology) and is in rapid development, thus being incapable of solving all the security problems. Because of this, the open Internet system may contribute to numerous information safety problems in the digital library computer network, which requires the users to employ the relative analytical test method, the "t" test method:

$$t = \frac{|\bar{d} - \mu_d|}{s_d} = \frac{\bar{d} - \mu_d}{s_d / \sqrt{n}}, \quad (3)$$

in the process of the digital library computer network management, to verify its security and promote the awareness of protecting its information, thus ensuring the security of the digital library computer network.

IV. THE PRACTICAL EXPLORATION OF THE SECURITY TECHNOLOGY IN THE DIGITAL LIBRARY COMPUTER NETWORK

According to the above-mentioned security problems and the analytical study of the security technology, it can be seen that the security problem in the digital library computer network will be a gigantic trouble to its information safety, which requires the practical measures in its security technology^[9,10].

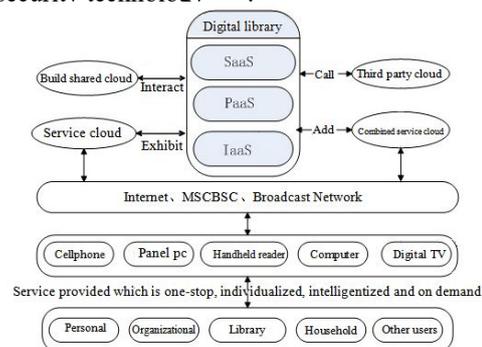


Figure 3 The Basic Structure Diagram of the Digital Library Computer Network

A. Applying the Security Technology to the Digital Library Computer Network According to the Library's Features

To effectively solve the security problem in the digital library computer network, the users may follow the trend of the development of its security technology, when using it and fully considering the the basic structure of Figure3 to purchase the corresponding firewall and anti-virus softwares(in general the anti-virus softwares and firewall technology will definitely make changes in accordance with the changes of the network security in computer communication, such as the ant-virus software Qihoo 360), to seclude the possible security problems in their infancy. Moreover, the related data inspection work should be actualized to evaluate the practical application value of the security technology in the digital library computer network, the relevant data being aggregated, checked and analyzed via the probability theory:

$$F = \sum T / (x^2 + y^3), \quad (4)$$

to work out the normal application value of its security technology.

Analyzing the application effect of the security technology can guarantee the safety of the management of its data, hence efficiently solving the problem and keeping the data information which are possibly hazardous from connecting network. Besides, almost all of the computers have been installed the anti-virus software on, which can search out the possible viruses in the digital library computer network, thus ensuring the information safety of the users.

B. Optimizing the Digital Signature Technology in the Security Technology Applied to the Digital Library Computer Network

Digital signature is one of the most effective ways to ensure the security technology in the digital library computer network. The digital signature technology, to be specific, can define the security of the documents and prevent the data information from being stolen by external forces. In general case, digital signature technology can be employed in each phase of its security management and can make sure that the information of the digital library computer network is under utmost protection by providing to the digital library computer network a security password and the like. The fundamental structure of the application of the digital signature technology is illustrated in Figure 4.



Figure 4 The Fundamental Structure of the Application of the Digital Signature Technology

Furthermore, the orthogonal test method is also used in the orthogonal experiment design of digital signature technology in the security technology of the digital library computer network, in which it is found that the security technology, under different application conditions, is prone to relatively good application effects:

$$F = \int G(x) * M(x). \quad (5)$$

Such a situation illuminates that applying the digital signature technology in the process of Internet data information management can ensure the complete Internet management of the data and guarantee the legitimate interests of the users.

C. Optimizing the Information Protection Degree of the Digital Library Computer Network

The most important part for the users of the digital library computer network in their using the Internet information is to strengthen their own awareness of information protection, in order to prevent the core interests of the digital library computer network from being infringed. For instance, the users can set the corresponding security questions (such as the mobile phone dynamic password in Tencent) when logging in the digital library computer network, and should be careful, when in information exchange, not to thoughtlessly transfer the account information to the Internet and,

what's more, are supposed to set a password with high security performance when setting a password in lieu of one with low security performance merely for convenience, to ensure that the core interests of the digital library computer network are not infringed. Applying the security technology to the digital library computer network, to prevent the core interests from infringement, requires monitoring and processing the data management state in real time, which is, to be specific, a sort of real-time monitoring and protection to the security performance of the management in the process of the information management. In general, the safety protection measure employed is the timely examination of the security status of the digital library computer network. If security problems are found in its examination, the corresponding security patch demands downloading in time to redress the vulnerability and problems in the digital library computer network. Besides, the appropriate professional softwares are to be utilized in scanning and inspecting the information of the digital library computer network to guarantee the validity of the vulnerability inspection. For instance, such softwares as Kaspersky and 360 safeguard can be applied to the scansion and inspection, to ensure the well-timed remedy for the vulnerability in managing the digital library computer network.

V. CONCLUSION

In conclusion, the development of the computer science and technology furnishes to the masses more methods of information management, hence increasing the efficiency, whereas a substantial number of security problems pervade the digital library computer network when it is used, because of which researches on the security problems in the digital library computer network are necessary, beginning from improving the security technology level and the users' security awareness, eliminating the potential security hazards in their infancy and thus efficiently solving the security problem in the digital library computer network.

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Universities of Nationalities Network Self-determined Learning Effects Monitoring and Evaluation Research

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Abstract—Popularization of universities of nationalities network self-determined learning has greatly improved teaching speed, and with the rapidly development of universities learning digitalization and informatization, network campus implementation lets campus learning cultures to have new platforms and environment. In universities of nationalities, apply network to carry out self-determined knowledge learning, its attributes have high capacity, fast timeliness, rapidly updating as well as other features. The paper utilizes comprehensive evaluation model to make fuzzy comprehensive evaluation on universities of nationalities network self-determined learning effects, carries out evaluation and analysis from network learning tools, sites, network learning time distribution, universities network learning attention, universities network self-determined learning contents. It gets good evaluation results.

Index Terms—Universities of nationalities, Network self-determined learning, Fuzzy comprehensive evaluation, Mathematical model

I. INTRODUCTION

Usage of network cannot do without contemporary university students, in university students daily learning life, chat, communication, e-mail, news, videos and other various aspects, all reflect network importance, the paper gets year 2010-2011 each kind of network application usage rate (partial), by data indication, it gets status analysis, as Table 1 shows [1].

TABLE 1:

YEAR 2010-2011 ALL KINDS OF NETWORK APPLICATION USAGE RATES

| Application | Year 2011 | | Year 2010 | | Annual growth rate |
|-----------------------|---------------------------|------------|---------------------------|------------|--------------------|
| | User scale(ten thousand) | Usage rate | User scale(ten thousand) | Usage rate | |
| Instant messaging | 41510 | 80.9% | 35258 | 77.1% | 17.7% |
| Search engine | 40740 | 79.4% | 37453 | 81.9% | 8.8% |
| Network music | 38585 | 75.2% | 36218 | 79.2% | 6.5% |
| Network news | 36687 | 71.5% | 35304 | 77.2% | 3.9% |
| Network videos | 32531 | 63.4% | 28398 | 62.1% | 14.6% |
| Network games | 32428 | 63.2% | 30410 | 66.5% | 6.6% |
| Blogs/ personal space | 31864 | 62.1% | 29450 | 64.4% | 8.2% |
| Micro-blog | 24988 | 48.7% | 6311 | 13.8% | 296.0% |
| E-mail | 24577 | 47.9% | 24969 | 54.6% | -1.6% |
| Social network site | 24424 | 47.6% | 23505 | 51.4% | 3.9% |
| Forum/BBS | 14469 | 28.2% | 14817 | 32.4% | -2.3% |
| Traveling reservation | 4207 | 8.2% | 3613 | 7.9% | 16.5% |

By Table 1 expressed results indicating, the paper carries out evaluation and analysis from network learning

tools, sites, network learning time distribution, universities network learning attention, universities network self-determined learning contents

II. MODEL ESTABLISHMENTS

A. Generalization of fuzzy comprehensive evaluation model

Utilize fuzzy comprehensive evaluation, steps are as following:

Establish factor set $U, U=(U_1 U_2 \dots U_k)$

(2)Establish evaluation set V (assessment set), $V=(V_1 V_2 \dots V_n)$

According to general evaluation system, define evaluation grade domain:

$$V = \{V_1, V_2, V_3, V_4\}$$

= {very good, good, normal, bad}

(3)Establish evaluation matrix fuzzy mapping from U to V , it gets fuzzy relation as following matrix shows:

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & \dots & \vdots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}$$

(4) Establish weight set, $A=(a_1, a_2, \dots, a_n)$, it meets

$$\sum_{i=1}^n a_i = 1 \quad a_i \geq 0$$

conditions: (5) Fuzzy relation R every line will reflect the line influence factors to object judgment degree, meanwhile, R every column will reflect the column influence factors to object judgment degree.

$$\sum_{j=1}^n r_{ij} \quad j = 1, 2, 3, \dots, m$$

$$B = A \cdot R$$

$$= (a_1, a_2, a_3, \dots, a_n) \cdot \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & \dots & \vdots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}$$

$$= (b_1, b_2, b_3, \dots, b_n)$$

In V , fuzzy combination is evaluation set B . Based on above described facts, actual change model is:

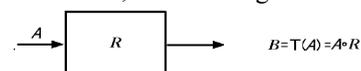


Figure 1 Change model

As Figure 1 show, it gets fuzzy comprehensive evaluation change model, and can establish

corresponding every factor grade evaluation transformation function, evaluation factors u_1, u_2, u_3, u_4, u_5 membership functions can be expressed as following:

$$u_{v_1}(u_i) = \begin{cases} 0.5(1 + \frac{u_i - k_3}{u_i - k_2}), & u_i \geq k_1 \\ 0.5(1 - \frac{k_1 - u_i}{k_1 - k_2}), & k_2 \leq u_i < k_1 \\ 0, & u_i < k_2 \end{cases}$$

$$u_{v_2}(u_i) = \begin{cases} 0.5(1 - \frac{u_i - k_1}{u_i - k_2}), & u_i \geq k_1 \\ 0.5(1 + \frac{k_1 - u_i}{k_1 - k_2}), & k_2 \leq u_i < k_1 \\ 0.5(1 - \frac{u_i - k_3}{k_2 - k_3}), & k_3 \leq u_i < k_2 \\ 0.5(1 - \frac{k_3 - u_i}{k_2 - u_i}), & u_i < k_3 \end{cases}$$

$$u_{v_3}(u_i) = \begin{cases} 0, & u_i \geq k_2 \\ 0.5(1 - \frac{k_1 - u_i}{k_2 - k_3}), & k_3 \leq u_i < k_2 \\ 0.5(1 + \frac{k_3 - u_i}{k_2 - u_i}), & u_i < k_3 \end{cases}$$

B. Combine with fuzzy evaluation model to evaluate universities of nationalities network self-determined learning effects

Establish factor set $U, U = (U_1 U_2 U_3 U_4)$. Among them, network learning tools, sites U_1 , network learning time distribution U_2 , universities network learning attention U_3 , universities network self-determined learning contents U_4 , it gets Table 2.

By Table 2 listed factors, it gets evaluation set.

$$U_1 = \{u_{11}, u_{12}, u_{13}, u_{14}\}$$

$$U_2 = \{u_{21}, u_{22}, u_{23}, u_{24}, u_{25}\}$$

$$U_3 = \{u_{31}, u_{32}, u_{33}\}$$

$$U_4 = \{u_{41}, u_{42}, u_{43}, u_{44}\}$$

By collecting data and analyzing, it gets four kinds of factors importance ranking statistics, as Table 3 show.

TABLE 2: UNIVERSITIES OF NATIONALITIES NETWORK SELF-DETERMINED LEARNING EFFECTS EVALUATION INDICATOR SYSTEM

| Network learning tools, sites U_1 | Network learning time distribution U_2 | Universities network learning attention U_3 | Universities network self-determined learning contents U_4 |
|--|--|---|--|
| Instant messaging, campus information issuing u_{11} | Network learning time u_{21} | Network real-time learning news u_{31} | University network learning course u_{41} |
| Inside and outside school network learning timeliness u_{12} | Computer literacy learning u_{22} | Network course distribution u_{32} | University network learning homework u_{42} |
| Network video learning u_{13} | Network course education time u_{23} | Teachers' focus u_{33} | Universities network learning examination u_{43} |
| Network learning phase self testing u_{14} | Other network used time u_{24} | Universities policies u_{34} | |
| Experience sharing u_{15} | | | |

TABLE 3: FOUR KINDS OF FACTORS IMPORTANCE DEGREE RANKING STATISTICS

| Classification | Rank1 | Rank2 | Rank3 | Rank4 |
|--|-------|-------|-------|-------|
| | | 23 | 7 | 4 |
| Network learning tools, sites U_1 | 23 | 7 | 4 | 0 |
| Network learning time distribution U_2 | 7 | 18 | 8 | 0 |
| Universities network learning attention U_3 | 0 | 9 | 13 | 12 |
| Universities network self-determined learning contents U_4 | 3 | 0 | 9 | 21 |

By Table 3 sorting, it gets network learning tools, sites, network learning time distribution, universities network learning attention, universities network self-determined learning contents four aspects' rank matrix [2]:

$$U_1 = \{23, 7, 4, 0\}; U_2 = \{7, 18, 8, 0\}$$

$$U_3 = \{0, 9, 13, 12\}; U_4 = \{3, 0, 9, 21\}$$

Obtained weighted vector from rank 1 to rank 2:
 $\beta = \{\beta_1, \beta_2, \beta_3, \beta_4\} = \{0.4, 0.3, 0.2, 0.1\}$

$$U_i^* = U_i \cdot \beta^T$$

$$U_1^* = 12, U_2^* = 9.7, U_3^* = 6, U_4^* = 5$$

The paper takes normalization processing:

$$U_1^* = 0.35, U_2^* = 0.3, U_3^* = 0.2, U_4^* = 0.15$$

$$\bar{A} = (0.35 \quad 0.3 \quad 0.2 \quad 0.15)$$

It gets:

By universities network psychological measurement, the paper gets remarks membership, as Table 4 show.

TABLE 4: UNIVERSITIES OF NATIONALITIES NETWORK SELF-DETERMINED LEARNING EFFECTS REMARKS MEMBERSHIPS

| Evaluation way | Set scores interval | | | |
|----------------|---------------------|-------|-------|--------|
| | 0-60 | 60-80 | 80-90 | 90-100 |
| Very good | 0 | 0 | 0.05 | 0.95 |
| Good | 0 | 0.05 | 0.9 | 0.05 |
| Normal | 0.05 | 0.9 | 0.05 | 0 |
| Bad | 0.95 | 0.05 | 0 | 0 |

By universities network psychological measurement each indicator obtained evaluation, the paper gets Table 5.

TABLE 5:

ONE UNIVERSITY OF NATIONALITIES NETWORK SELF-DETERMINED LEARNING EFFECTS EVALUATION EACH INDICATOR OBTAINED EVALUATION VALUE

| Each layer indicator | Evaluation value | Each layer indicator | Evaluation value |
|--|------------------|--|------------------|
| Instant messaging, campus information issuing u_{11} | Very good | Network real-time learning news u_{31} | Very good |
| Inside and outside school network learning timeliness u_{12} | Very good | Network course distribution u_{32} | Good |
| Network video learning u_{13} | Normal | Teachers' focus u_{33} | Good |
| Network learning phase self testing u_{14} | Normal | Universities policies u_{34} | Normal |
| Experience sharing u_{15} | Normal | University network learning course u_{41} | Good |
| Network learning time u_{21} | Very good | University network learning homework u_{42} | Very good |
| Computer literacy learning u_{22} | Very good | Universities network learning examination u_{43} | Normal |
| Network course education time u_{23} | Very good | | |
| Other network used time u_{24} | Good | | |

By above model, it gets single layer indicator weight factor fuzzy set is:

$$U_1^* = \{U_{11}, U_{12}, U_{13}, U_{14}, U_{15}\} = \{0.25, 0.25, 0.2, 0.15, 0.15\}$$

$$U_2^* = \{U_{21}, U_{22}, U_{23}, U_{24}\} = \{0.54, 0.1, 0.24, 0.14\}$$

$$U_3^* = \{U_{31}, U_{32}, U_{33}, U_{34}\} = \{0.4, 0.3, 0.1, 0.2\}$$

$$U_4^* = \{U_{41}, U_{42}, U_{43}\} = \{0.3, 0.4, 0.3\}$$

By Table 5, and combine with Table 3 remarks membership, the paper gets network learning tools, sites, network learning time distribution, universities network learning attention, universities network self-determined learning contents each aspect evaluation set [3, 4]:

$$U_1 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.95 & 0.05 \\ 0 & 0.05 & 0.95 & 0.05 \end{pmatrix}$$

Network learning tools, sites—
Network learning time distribution—

$$U_2 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.05 \end{pmatrix}$$

Universities network learning attention—

$$U_3 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.05 \\ 0 & 0.05 & 0.9 & 0.05 \\ 0.05 & 0.9 & 0.05 & 0 \end{pmatrix}$$

Universities network self-determined learning

$$U_4 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.05 \\ 0 & 0.05 & 0.9 & 0.05 \end{pmatrix}$$

contents—
By formula calculating:

$$B_i = A_i \cdot R_i$$

Make normalization processing with obtained B_i , it gets fuzzy evaluation matrix:

$$\bar{B} = \begin{pmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{pmatrix} = \begin{pmatrix} 0.07 & 0.27 & 0.12 & 0.54 \\ 0 & 0.1 & 0.42 & 0.48 \\ 0.08 & 0.45 & 0.29 & 0.18 \\ 0.15 & 0.21 & 0.3 & 0.34 \end{pmatrix}$$

It gets comprehensive evaluation value :

$$Z = U^* \cdot B = (0.32 \ 0.28 \ 0.22 \ 0.18)$$

By comprehensive evaluation value $0.32 > 0.28 > 0.22 > 0.18$, it shows universities network self-determined effects evaluation indicators located indicator range is in the interval of 80-90 scores.

III. CONCLUSION

Fuzzy mathematics is from people recognition on external world, due to suffer numerous factors influences, human recognized things are fuzzy. Fuzzy mathematics is a theoretical system that is formed by fuzzy set and fuzzy logic, fuzzy mathematics is applied in pattern recognition and artificial intelligence, as a relative brand new discipline, fuzzy mathematics collect some uncertain factors and then reflect into people consciousness. By establishing attributes scale on one object, carry out fuzzy mathematical analysis of one object.

The paper gets comprehensive evaluation value by fuzzy comprehensive evaluation model analysis, carries out evaluation and analysis from network learning tools, sites, network learning time distribution, universities network learning attention, universities network self-determined learning contents; by comprehensive evaluation value $0.32 > 0.28 > 0.22 > 0.18$, it shows located indicator range is in the interval of 80-90 scores, therefore it indicates contemporary universities of nationalities network self-determined learning effects evaluation index is lower that should attract higher attentions.

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Discussion on Theoretical Research and Practical Application of Green Agro-Ecological Compensation

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Abstract—Green Agriculture refers to all forms and modes of modern agriculture which in favor of environmental protection and ensures the quality and quantity of agriculture products. Many countries in the world today have achieved certain results in theory and practice of Agro-ecological Compensation. IN order to further promote the development of Green Agriculture in China and establish a Green Agro-ecological Compensation Mechanism which suitable for China's national conditions, the author summarized the existing domestic and foreign articles on Green Agro-ecological Compensation, based on the content of concept, theoretical basis and standards of Ecological Compensation, and systematically analyze and summarize the progresses made by China in Green Agro-ecological Compensation and practical situations of countries who develop Green Agro-ecological Compensation by means of government financial transfers, supplementary market financing and legal supervision and control. Learn from the practical experience of the developed countries in the Agro-ecological Compensation policies and regulations, financial support and Compensation Mechanisms, the author concluded problems to be solved in theoretical and practical levels of China Green Agriculture Ecological Compensation and lessons learnt from developed countries: More attention should be paid on support in terms of government policies, laws and regulations, eco-compensation standard accounting and options for pilot range, to choose the right pilot, gradually develop from the pilot to scale, to give solutions for agricultural nonpoint source pollution, improve agro-ecological environment and ensure food safety, according to the Chinese national conditions and local conditions.

Index Terms—Agriculture, Ecological Compensation, Research progress

I. INTRODUCTION

In order to effectively resolve the problem of coordination between green agriculture and economic development, it is very important to establish the mechanism of green agro-ecological compensation. Since the 1980s, many countries and regions adopted a series of agro-ecological compensation measures and there were a large number of agro-ecological compensation practices. Although many scholars discussed the framework system, laws regulations and compensation standards of agro-ecological compensation, there were no green agro-ecological compensation theoretical system and the recognized standards of accounting methods. This paper attempts to summarize the development process and present research by combing the literature and analyzing the existed social practice in order to provide a reference

for establishing green agro-ecological compensation mechanism.

II. RESEARCH PROGRESS OF GREEN AGRO-ECOLOGICAL COMPENSATION

A. The concept of green agro-ecological compensation

The so-called green agro-ecological compensation is a system arrangement to pay compensation costs for green agricultural products and green agro-ecological services. It is a mode of agricultural production which inspires people to change the means of high consumption and high pollution by paying direct costs and opportunity costs to operators who adopt some measures to protect ecological environment, such as ecological protection and ecological restoration. The operators adopt the mode of green agricultural production in order to achieve the aims that protect and improve the ecological environment, enhance ecosystem services and improve the overall efficiency of agriculture, and ultimately to achieve harmony and unity among the economic benefits of agriculture, social benefits and ecological benefits. This concept is based on the definition of ecological compensation in the international arena. In the international arena, scholars rarely use the definition of ecological compensation, generally used is payments for ecological or environmental services, (referred to as PES). Its meaning is closed to the definition of ecological compensation which is popular used in China. It is an effective way which can transform an external, non-market environmental values to real financial incentives whose goals is to encourage participants provide more ecosystem services. During the past 20 years, especially since the Rio de Janeiro on environment and development conference, with the increasingly demand for ecological compensation system and a large number of spontaneous cases appeared in practice, the issue of ecological compensation has become a common problem among multi-disciplinary. There are five hot areas in China on the study of ecological compensation: eco-compensation standard accounting methods, forest benefit ecological compensation, watershed ecological compensation, large-scale ecological construction projects ecological compensation and the main functional areas of ecological compensation. In the course of the agro-ecological compensation study, scholars use the different concepts, some with the concept of environmental protection agriculture, and some with the concept of environment-friendly agriculture. The authors believe that these types of agriculture can be considered to be synonymous to green agriculture. Because the so-called green agriculture is a modern pattern which conducive to environmental

protection and ensure the safety of agricultural products quantity and quality. OU Wang and Hongyuan Song (2005) argues that agro-ecological compensation is a long-term mechanism which can optimize the use of the overall protection of agricultural resources, quality and safety of agricultural products, agro-ecological environment and maintain the regional economic and social development in harmony. Tiechao Tang, Yanhui Bian, FengLiu ect.(2011)take the project of "Environment strategy of intensive agriculture in north of China "which between China and German combining with the practice of compensation principle, compensation object, compensation standard, compensation form, compensation aspect, compensation supervision launched some discussions. And put forward that the environmental -friendly agriculture should be oriented on projects (governmental) subsidies, on the prerequisite of voluntary of farmers, take the backbone of farmers, farmers' professional cooperatives as the main objects of compensation, the combined technical matter as the main form of compensation to take into account the ecological, economic and social goals. Anxuan Kuang (2009) believes that agro-ecological compensation is emphasized on the functions of agro-ecological, and points out that ecological compensation is based on the protection and sustainable use of ecosystem services for the purpose of institutional arrangements mainly through economic means to adjust the interests of the stakeholders. What can be seen from the above, different scholars' understanding on the concept of agro-ecological compensation covers the purpose and scope of the green agro-ecological compensation, but different studies on its definition are various. Yuanquan Chen, Wangsheng Gao,(2007)took the example of the comparison between traditional agriculture and ecological-protection agriculture and put forward the decision conceptual model of agro-compensation.It is pointed out that the government must take full account of the value of ecosystem services in agriculture decision-making, establish the agro-ecological compensation mechanism to ensure the sustainable development of agro-ecological.

B. References

The theoretical basis of the green agro-ecological compensation

Economics—the theory of externality and the public goods. This is the theoretical basis of ecological compensation because the reasons of unreasonable development of resources use and environmental pollution is external. The producers generally bear the cost of production, while no or only bear part of the costs and external costs. The essence what caused the eco-social of external diseconomies is the socialization of private costs. Therefore, make the external economic internalization caused by external economic consequences borne by the perpetrator which is to establish the economics basis of the ecological compensation mechanism.The production of green agriculture has the typical external characteristics, the services function which provided by the green agro-ecosystems, especially the life function and ecological function are public production to some large extent. Due to its non-competitive often leads to over-development of using agriculture resources, and ultimately the interests of

all members are damaged. Its non-exclusive would engender a "free rider" mentality, no one is willing to provide public goods, and the result is no one can enjoy the public goods. To solve this problem, government regulation and government foot the bill is one of the mechanisms that effectively solve the public goods.

Ecology—multi-functional theory of agriculture. The concept of agriculture multi-functional first appeared in Japan's "rice culture", "rice culture" is the culture which emphasis rice production has an important cultural function and value, rice production in the prevention of soil erosion, protect vegetation, water conservation, prevention of soil erosion and soil erosion, the treatment of organic waste, air purification, green and natural landscape, as well as traditional cultural inheritance multifaceted role. Multi-functional of agriculture refers to the agricultural sector in additional to the production of grain and other agricultural products, agriculture also bear an increasingly important and expanding economic, ecological, environmental, social stability and social functions. In other words, agriculture can not only ensure a stable supply of food, but also can bring a variety of social, ecological, cultural and other aspects of utility.

Sociology- the interests of fairness. Ecological construction need to adjust the economic structure, cropping patterns , consumption patterns, involving a large number of economic loss, this will enviably reduce the speed of development and people's living standards temporarily, and also lead to temporary loss of the ecological construction and environmental governance, economic efficiency and development speed. If there are a lot of financial compensation and financial assistance, make the economic losses withstand the range of eco-builders and then they are willing to actively carry out ecological construction.

C. Standard estimation of Green agricultural eco-compensation

In the process of the implementation of ecological compensation, the compensation standard is the core of the problem, and also is a hot and difficult problem. Access to the literature of the past five years, it can be seen more and more attention are forced on the ecological compensation standard calculation method. The standard of compensation is too high will reduce the efficiency of the utility of compensation funds. The standard of compensation is too low would undermine the interests of the objects of compensation and influence their enthusiasms in the implementation of ecological compensation. Due to the comprehensive and complex of ecological compensation, as well as a large number of environmental data is difficult to obtain, the accounting of the ecological compensation standard is still constrained by numerous factors. At present, there are still a lot of different views on how to establish the standard of compensation, the standard of compensation is still the core problem to be solved at this stage. To sum up, there are two main ideas: the first is the valuation of ecosystem services; the second is to calculate the opportunity cost of the supply of ecosystem services. there are some different advantages and disadvantages to these two ideas accounting for ecological compensation standards. ZengTang and Zhongmin Xu (2010) argue that it is difficult take the results of the assessment of the

value of ecosystem services as the basis for eco-compensation standard, the best method should be based on cost accounting. The team put forward using the method of minimum data to determine the best compensation standard under the target of ecological environment restore. The Fig.1 shows the process of using the minimum data to determine the standard of compensation.

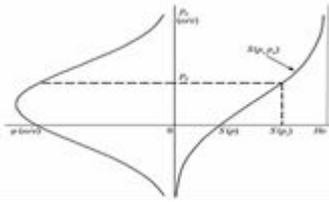


Figure 1. The process of establishing compensation standard using the method of minimum data

According to the opportunity cost curve which is on the left can deduce the supply curve of ecosystem services which is on the right. Under the condition of knowing the new added supply target S (P_e) of ecosystem services, it can be calculated the compensation standards P_e .

Yanli Han, Kelong Chen, Hairui Duo(2009) took the technology of “3S” as the support to study the compensation standard of Qinghai Lake and analysis the functional changes and ecosystem landscape structure by the means of shadow project, the market price, expenses, carbon taxes, energy substitution and the model of NNP. Xiaoguang Li, Hong Miao, Hua Zheng (2009) studied the major methods and applications of ecological compensation, they systematic summary the main methods of ecological standard which based on the theory of ecosystem services, marketed and the quasi-marketed and commented the principle of various methods, scope of application, characteristics and its typical cases. The team took the central mountainous area of Hainai province as a case to study the method of opportunity cost which is widely used in the practice, and pointed out that the most basic factor in the method of opportunity cost is to be able to find a suitable carrier, that is to say use the carrier as the foundation to quantitative the opportunity cost of ecological protection. Meanwhile, they believed that the risk factors are also the main factors which influence the compensation standards. Xueyan Zhao, Xia Dong (2010) took the case of Gannan Yellow River water recharge area, analyzed the application of ecological compensation using the method of minimum data, and believed that due to this method require less data and is accurate enough is could be used to decision-making analysis services.

III. THE PRACTICAL EXPERIENCE OF GREEN AGRO-ECOLOGICAL COMPENSATION

Internationally, in accordance with the concept of environmental services or ecosystem services to pay, in order to further protect the ecological environment and promote sustainable development of agriculture, the United States, Japan, the European Union and the Germany respectively introduced a series of policies and regulations to strengthen the agriculture ecological compensation. Among the agricultural policy of environmental protection, agro-ecological compensation

has become an important means which can change the farmers' production methods, the use of environmentally friendly agricultural production technologies, and the protection of agricultural product quality safety and protection of agricultural ecological environment. Drawing on the international experience, it can promote to establish the agro-ecological compensation mechanism in China and protect the agricultural ecological environment, safeguard the quality and safety of agricultural products and improve their international competitiveness. The implementation of agro-environmental laws and the policy of agro-ecological compensation make the agro-ecological environment have been significantly improved. Such as to link the price subsidies and environmental measures, adjust the structure of agriculture, reduce the pressure of environment, and change the mode of agricultural production, forestation and so on.

The united states always attention the agricultural production and the development-related resources, ecology, environmental protection, formulate a series of environment regulations and long-term plans about protecting arable land, water and other natural resources and ecological environment which can promote the sustainable development of agriculture. In Japan, there are agricultural improvement funds to enhance the natural circulation function of utility projects and the transformation of green manure and compost soil continued to dry farming projects in an integrated response to the cause of the agricultural production. The point of departure on international is to pay compensation for the improvement of specific beneficiaries, boils down to help pay and service both. The logic is to meet the environmental needs of those who pay for personal ecological improvement.

About the start time on the Chinese eco-compensation practice, scholars have a little controversy, one view believe the ecological compensation started in the 1970s, Due to the lack of forest protection funds, Sichuan Qingcheng mountain forest hack rampant deforestation which made it was faced with the ecological crisis, later, the Chengdu Municipal Government decided to take 30% of ticket sales of Qingcheng Mountain on forest protection, and established as a system which creating a forest ecological benefit compensation. The other views believe that began in 1983 in Yunnan Province of phosphate rock mining collection of vegetation and other ecological damage to the environment restoration costs. In 1984, the levy of resource compensation officially opened the prelude to China's eco-compensation practice. From the 1990s, the Chinese government set up a pilot ecological compensation in Guangxi, Fujian and other places to have initiated the Grain for Green Project in 2002, grazing-for-grass works, protecting natural forests and other major ecological construction projects and then to the 2006 China Environment and Development International Cooperation Committee completed a study of ecological compensation mechanism and policy issues, the initial establishment of the theoretical framework of ecological compensation. In recent years, different countries and scholars in different regions of the agro-ecological compensation has launched a large number of studies and achieved good results, such as carried out in Latin American countries of PES, project initiated by the

World Bank, Europe's agricultural economy project, Chinese Grain for Green project.

Yuanquan Chen, Xiaobin Dong, Wangsheng Gao(2006), discussed the agro-ecological compensation of the Loess Plateau Hongyu Wang, Lijun Wang(2008) studied the mechanism of ecological compensation of the Mopan headwater area, and pointed out that under the situation of funds can't solve the relocation of the agricultural population, it is a feasible measure to develop green food and organic food to reduce reservoir water quality affected by pesticides, fertilizers, non-point source pollution in recent years. Xia Zhao, Fangwei Wu(2008) discussed the mechanism of agro-ecological compensation, and put forward some policies to comply with the regional development. Hongyu WU, Fengjuan Ma(2010) analysis the necessary and basis to establish the mechanism of agro-ecological compensation, and comment the existed problems and put forward the relevant policy to improve the public ecological awareness. Shaoyun Ge(2010) studied the systems of agro-ecological compensation, combined with the reality of Gansu Province, put forward a few key issues to improve the agro-ecological environment. Jiangting Shao(2010) concluded the current situation and existing problems of the agro-ecological compensation by sample analysis and empirical research, and further reveal the plight of China's agro-ecological compensation. Huang Qiu(2010) on the basis of studying a large number of literatures and practical cases, analysis the way for government compensation mechanisms and market compensation mechanism, especially compared the advantages and limitations between them and discussed the proposed improvement of agro-ecological compensation legal mechanisms for specific ideas. Jingshu Jin (2011) completed his doctoral dissertation on the necessity and feasibility of agro-ecological compensation from the analysis of the agro-ecological environment. Yun Zhao, Keqiang Zhang, Peng Yang(2011) studied the agro-ecological compensation of Erhai Lake.

IV. THE PROBLEMS AND THE REVELATIONS

A. Problems

The level of theory and method. Theoretical studies have not form a system. After reading extensive literature, in can be concluded that the theory and practice about green agro-ecological compensation tend to increase in breadth, but most research has focused on the discussion of case studies instead of the basic principles, there are on the same principle repeated applications has not yet formed a complete theoretical system.

Quantitative evaluation is inadequate. Among the researches on the compensation standard for green agro-ecological, the theoretical discussion and qualitative analysis are more than quantitative analysis and empirical research. Most researches are macro-theoretical discussion. Almost no studies are on the evaluation of effectiveness of compensation. Meanwhile, the current method has high requirements for data, how to obtain the most direct and useful information to ensure data authenticity is one of the difficulties of research.

The level of implementation. Green agro-ecological compensation has remained mostly in the theoretical study, pilots are less.

In addition to the large national ecological construction projects outside the project such as returning farmland to forest and grazing for grass, the existing researches reflected the agricultural ecological compensation areas are Gansu, Loess Plateau, and Erhai and so on. Relative to the Promotion of the goal of sustainable development of green agriculture, the pilots are still very few; this research is still in its infancy.

Laws and regulations are not complete. Although China has launched some pilots' demonstration of returning farmland to forests, conservation tillage and has achieved some success, but for the farmers to take to reduce the use of chemical fertilizers, pesticides, organic manure, environmentally friendly and resource-saving production measures there are not compensation policy, it is difficult to mobilize the enthusiasm of farmers for environmental protection. The lack of relevant legislation will directly affect the implementation of green agro-ecological compensation. In the construction of ecological compensation laws and regulations, the scholars also expand the initial study: Feng Zhang (2010) explore the design of mechanism and legal protection in her monograph, and take Shandong province as an example discussed the legalization of countermeasures.

Other scholars also have discussed about the legal mechanisms of eco-compensation such as Qingjun Wang (2008), Huang Qiu(2010), Limei Liu, Xueping Han(2009), Yan Zhang, Biaodan Pang, Yue Ma(2011), Zunmei Liu, Xueping Han(2011) Jingyun Li (2010) and so on.

B. Inspiration

The study on green agro-ecological compensation in China is still at the exploratory stage, it is needed to have a groundbreaking breakthrough both in breadth and depth. Study appropriate experience to learn from other countries, China need to launch researches according to the actual situation. Meanwhile, it is needed to select some relatively mature methods in other areas of eco-compensation and select a number of pilot lights of local conditions to conduct research and promote the improvement of the ecological compensation mechanism of green agriculture.

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University Students' Emergency Capability Research by Eye Movement Experiment

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Abstract—In recent years, the frequently happenings of the “Campus Emergencies” forces colleges to face and pay attention to the campus crisis management and student’s emergency ability. So it is necessary to measure the emergency ability of college students, thus universities can give different emergency levels of students to different education. However, the method of mostly measuring emergency capability based on subjective perception such as in the form of questionnaires. In this paper, the eye movement test with the Tobii Eye Tracker is used to study student’s hazard identification and emergency capability in different emergency scenarios by Visit count and Time to First Fixation and others eye movement parameters. Results indicate that most students have some abilities to identify hazard and dispose emergency situations; Students received emergency education have more hazard recognition and emergency disposal abilities than those have no trained emergency education; Gender factor is no significant difference in emergency response and emergency ability. The ultimate purpose through comparative analysis of emergency level of college students from different backgrounds by grouping is to provide a reference for the establishment of a reasonable campus crisis management system and improve college student’s comprehensive ability to deal with crises.

Index Terms—emergency capability; eye movement experiment; emergency disposal capability; hazard recognition ability

I. Introduction

In recent years, the frequently happenings of the “Campus Emergencies” not only threatens the order of teaching, campus management and life between teachers and students of universities, but also damages images and reputations of the universities. Students should have some emergency capabilities, once appearing near misses can they take timely effective emergency measures. But the fact shows a large number of campus crises and further harm are related to their inappropriate emergency response. So depth study of college students making emergency response when Campus crisis happened and scientific assessment of individual ability to react to emergency scenes play an important role in the prevention of campus crisis events and reduction of accident losses.

Although scholars researched on the assessment to emergency response and emergency capability earlier, Outcomes related to the individual emergency response and emergency capability assessment are still rare. The representative achievements are as follows: Karen S. Hammad (2011) tested nurses’ emergency capacity in anxious Diagnostic centers of all major cities in South America, and proposed relevant education and training are necessary to improve nurses’ emergency ability. Ben Woodcock (2012) studied how the human factors impact the emergency response capacity in

high-risk industry, and designed emergency escape path and program of corresponding high-risk devices through considering the human factors. Miao Chenlin (2013) proposed evaluation indexes empowerment method of China’s coal mine emergency response capability by applying habitual domains, proved the index weights in equilibrium related to each control coefficient index. Deng Lihong (2012) studied emergency capacity measurement of command staffs based on physiological indexes of skin and heat rate and β wave.

Following this work, the present study carried out eye movement experience to analyze college students’ emergency capability. Aims of the study were: What about the emergency response of college student with different individual property? Whether they have skills and qualities to deal with emergency or not? How to find a effective path to improve students’ emergency capability?

II. Method

A. participants

A total of 30 subjects participated in the experiment for the emergency capability analysis, all subjects were recruited from Xi’an University of Science and Technology. The average age is about 23 years old or so, uncorrected or corrected visual acuity of 1.0 or more, no color blindness seruo or other eye diseases. Male to female ratio is 1:1. Half of subjects received emergency education and had emergency experience.

B. Experimental Instrument

Laboratory equipment is Tobii T60XL which can provide high-quality eye tracking in any gaze angle for wide-screen and measure automatically gaze position within 17 milliseconds (60Hz). It can accurately test eye movement parameters to the display images made by subjects. High-quality speakers and built-in network cameras can replay the sound stimuli and record facial expressions of those tested.

C. Experimental Materials

The trend of modern psychology is to raise the value of the direct application of experimental results (Qu Pengzhi, 2004). Experimental materials in this study are different campus crisis scene pictures including cartoon and reality scenes. There are 8 different types of emergency scenarios, each type has 6 pictures.

D. Experimental program

According to experimental purposes, the tested will be divided into three groups those are different gender and different emergency knowledge levels and emergency experiences, to explore student’s emergency hazard identification capability and emergency capability when watching 8 different types of emergency scene pictures including improper response and correct emergency response.

E. Experiment procedure

Step1 subjects alone enter in the lab, after sitting in the seat, adjust the eye tracker to the pre-use state.Step2 open eye tracker and calibrate experiments, inform subjects not to move freely in the experiment.Step3 start experiment, each emergency scene image presents five seconds, subjects try to imagine themselves in the emergency scene, then identify the hazard area and make a choice, time up the system automatically switches to the next picture.Step4 after the eye movement test, subjects will be asked to fill in the questionnaire, to learn more about additional information.

F. Eye movement Data analysis indicators

- Interests of Area. Interest of Area (AOI) is that the subjects are interested in the area of emergency scene pictures.
- Eye movement analysis parameters. Total Fixation Duration is all fixations duration in an area of interest. It reflects the degree of difficulty of subjects extracting information from the area of interest. The longer dwell time, more difficult to extract information from AOI, or their ability to interpret AOI information is relatively weak. Visit count is the total visits from the first fixation point occurs in the AOI to the next fixation out of AOI. Total Visit Duration is the time from the first fixation began in area of interest to the next fixation out of the area of interest.

III. The results and analysis

A. Heat maps and fixation point trajectory analysis

The eye movement experiment tested 30 subjects, including 15 men and 15 women,the sample rate of all subjects is over 80%. Through the data stack,analyzing the experiment data ,get the heat maps and gaze plots in the experimental pictures.as follows in Figure 1.

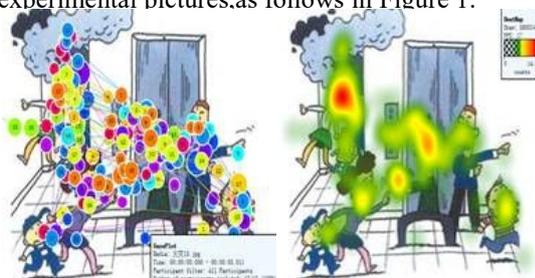


Figure 1. the heat map and gaze plots in fire scene

As shown in Figure 1 are the heat map and gaze plots pictures student watching fire emergency scene. Through visual analysis, we can obtain students' fixation point trajectory and eye movement characteristics when watching the fire emergency scene.In Figure 1 ,it can be seen clearly that college students watching the fire emergency scene in the picture mostly concentrated on the fire and the people fled area,and the concentration

effect is very obvious.This suggests that college students in the event of fire have the stronger ability to recognize danger.So subjects pay much attention to those areas.

B. The pupil size analysis

As shown in Table I analyzed 30 subjects pupil size(average) when looking at different pictures. Pupil size refers to the subject's eyeball diameter size after watching the materials to be tested.By analyzing the pupil size can we get the degree of interest which subjects care about .

TABLE I . Average pupil size

| picture material | Correct response pictures | Error response pictures |
|----------------------------|---------------------------|-------------------------|
| number of the participants | 44 | 44 |
| average pupil size | 2.68 | 3.74 |

Through analyzing 30 subjects' average pupil size in different emergency situations where people how to response to emergency crisis in images, found that the college students' pupil increase significantly when seeing improper emergency response in the emergency scene, and the pupil is relatively small when watching the correct response .It can be concluded that the improper emergency response pictures more attract the attention of college students, this shows that college students overall have safety consciousness to a certain degree and can be able to identify hazards in a state of emergency.

C. Eye movement Parameters analysis

The contents of the experiment material interest of area contain dangerous area and whether is right response area or not .Create the same size area of each picture of those areas as AOI, analyzing the eye movement indexes of these AOI,including Time to First Fixation and Total Fixation Duration and Total Visit Duration and Visit Count.

- Time to First Fixation.Through comparative analysis,when participants watched seismic image, Time to First Fixation of danger area is 1.33s. Average Time to First Fixation of correct emergency response area is 1.81s,Average Time to First Fixation of improper emergency response area is 1.07s.when participants saw fire picture,Time to First Fixation of danger area is 1.03s. Average Time to First Fixation of correct emergency response area is 1.72s,however Average Time to First Fixation of improper emergency response area is 0.38s.Similarly, college students watched other emergency scene pictures,Average Time to First Fixation of improper emergency response area is shorter than Average Time to First Fixation of correct emergency response area.It shows that most college students in emergency scenario tend to make the right emergency response and have strong emergency disposal ability.

TABLE II . Time to First Fixation of AOI eye movement data analysis

| Parameter | Earthquake Scenes | | | Plague Scenes | | | Fire Scenes | | |
|-----------|-----------------------|-----------------------|---------------------|----------------|-----------------------|---------------------|----------------|-----------------------|---------------------|
| | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |
| N | 13 | 12 | 13 | 12 | 11 | 12 | 12 | 11 | 12 |
| Mean | 1.33 | 1.81 | 1.07 | 0.95 | 1.78 | 0.96 | 1.03 | 1.72 | 0.38 |
| Sum | 17.31 | 21.75 | 13.96 | 11.36 | 19.76 | 10.94 | 12.36 | 18.91 | 4.55 |
| Stdev | 1.25 | 1.11 | 1.23 | 0.88 | 0.96 | 0.72 | 0.56 | 1.30 | 0.74 |
| | Food Poisoning Scenes | | | Suicide Scenes | | | Outing Scenes | | |
| Parameter | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |

| | | | | | | | | | |
|-------|------|-------|------|------|-------|-------|-------|-------|------|
| N | 11 | 9 | 12 | 13 | 13 | 11 | 11 | 10 | 13 |
| Mean | 0.19 | 2.88 | 0.63 | 0.64 | 1.96 | 2.43 | 1.78 | 1.56 | 0.26 |
| Sum | 2.05 | 25.89 | 7.55 | 8.3 | 25.48 | 26.77 | 19.53 | 15.56 | 3.14 |
| Stdev | 0.33 | 1.58 | 0.55 | 0.41 | 1.04 | 0.90 | 1.18 | 1.20 | 0.15 |

- Total Fixation Duration.by comparative analysis,when participants watched food poisoning image,Total Fixation Duration of improper emergency response area is 1.46s more than correct emergency response area 0.26s.when participants saw public plague picture,Total Fixation Duration of improper emergency response area is 0.88s more than correct emergency response area 0.67s.Similarly,college students watched other emergency scene pictures,Total Fixation Duration of improper emergency response to AOI is longer than correct emergency response to AOI.it indicates improper emergency AOI more attract subjects' attention.

TABLE III.
Total Fixation Duration of AOI eye movement data Analysis

| Parameter | Earthquake Scenes | | | Plague Scenes | | | Fire Scenes | | |
|-----------|-----------------------|-----------------------|---------------------|----------------|-----------------------|---------------------|----------------|-----------------------|---------------------|
| | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |
| N | 13 | 12 | 13 | 12 | 12 | 12 | 12 | 11 | 12 |
| Mean | 0.63 | 0.89 | 1.33 | 0.33 | 0.67 | 0.88 | 1.05 | 0.45 | 1.16 |
| Sum | 8.23 | 10.67 | 17.28 | 3.95 | 7.82 | 10.52 | 12.57 | 4.99 | 13.94 |
| Stdev | 0.55 | 0.40 | 0.82 | 0.09 | 0.34 | 0.51 | 0.47 | 0.24 | 0.88 |
| Parameter | Food Poisoning Scenes | | | Suicide Scenes | | | Outing Scenes | | |
| | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |
| N | 11 | 9 | 12 | 13 | 13 | 11 | 11 | 10 | 13 |
| Mean | 0.84 | 0.26 | 1.46 | 0.91 | 0.52 | 0.46 | 0.93 | 0.47 | 1.37 |
| Sum | 9.20 | 2.31 | 17.48 | 11.81 | 6.70 | 5.02 | 10.23 | 4.66 | 17.80 |
| Stdev | 0.32 | 0.08 | 0.40 | 0.51 | 0.32 | 0.22 | 0.44 | 0.32 | 0.63 |

- Total Visit Duration.When participants watched picture of school organizing outing,Total Visit Duration of improper emergency response area is 19.55s,but correct emergency response area is 4.75s.Total Visit Duration of improper emergency response area is obviously more than correct emergency response area.Similarly,college students watched other emergency scene pictures,Total Visit Duration of improper emergency response to AOI is longer than correct emergency response to AOI.Except for suicide scene,Total Visit Duration of watching correct response area is longer than improper emergency response area.

TABLE IV.
Total Visit Duration of AOI eye movement data analysis

| Parameter | Earthquake Scenes | | | Plague Scenes | | | Fire Scenes | | |
|-----------|-----------------------|-----------------------|---------------------|----------------|-----------------------|---------------------|----------------|-----------------------|---------------------|
| | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |
| N | 13 | 12 | 13 | 12 | 11 | 12 | 12 | 11 | 12 |
| Mean | 0.67 | 0.95 | 1.43 | 0.34 | 0.72 | 0.92 | 1.14 | 0.48 | 1.20 |
| Sum | 8.71 | 11.40 | 18.68 | 4.13 | 8.35 | 11.01 | 13.68 | 5.31 | 14.44 |
| Stdev | 0.62 | 0.43 | 0.84 | 0.09 | 0.39 | 0.52 | 0.53 | 0.26 | 0.90 |
| Parameter | Food Poisoning Scenes | | | Suicide Scenes | | | Outing Scenes | | |
| | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |
| N | 11 | 9 | 12 | 13 | 13 | 11 | 11 | 10 | 13 |
| Mean | 1.00 | 0.27 | 1.62 | 0.93 | 0.54 | 0.47 | 0.97 | 0.47 | 1.50 |
| Sum | 11.02 | 2.44 | 19.43 | 12.31 | 6.99 | 5.15 | 10.63 | 4.75 | 19.55 |
| Stdev | 0.60 | 0.08 | 0.50 | 0.54 | 0.34 | 0.23 | 0.47 | 0.33 | 0.68 |

- Visit Count.By analyzing Visit Count parameter,Visit Count of improper emergency response area is obviously more than correct emergency response area.it illustrates students more visit and concentrate on the dangerous areas of images when seeing different emergency scenes.

TABLE V
Visit Count of AOI eye movement data analysis

| Parameter | Earthquake Scenes | | | Plague Scenes | | | Fire Scenes | | |
|-----------|-----------------------|-----------------------|---------------------|----------------|-----------------------|---------------------|----------------|-----------------------|---------------------|
| | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |
| N | 13 | 12 | 13 | 12 | 11 | 12 | 12 | 11 | 12 |
| Mean | 2.00 | 1.75 | 2.54 | 1.08 | 1.76 | 2.05 | 2.00 | 1.64 | 2.33 |
| Sum | 26.00 | 21.00 | 33.00 | 13 | 20.05 | 25 | 24.00 | 18.00 | 28.00 |
| Stdev | 1.22 | 0.75 | 0.88 | 0.29 | 0.77 | 0.85 | 1.13 | 0.67 | 1.23 |
| Parameter | Food Poisoning Scenes | | | Suicide Scenes | | | Outing Scenes | | |
| | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |

| Parameter | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area | Hazardous Area | Correct Response Area | Wrong Response Area |
|-----------|----------------|-----------------------|---------------------|----------------|-----------------------|---------------------|----------------|-----------------------|---------------------|
| N | 11 | 9 | 12 | 13 | 13 | 11 | 11 | 10 | 13 |
| Mean | 2.36 | 1.11 | 2.58 | 2.26 | 1.38 | 1.36 | 1.73 | 1.50 | 2.69 |
| Sum | 26.00 | 10.00 | 31.00 | 29.05 | 18.00 | 15.00 | 19 | 15.00 | 35 |
| Stdev | 0.67 | 0.33 | 0.79 | 1.51 | 0.51 | 0.67 | 0.79 | 0.85 | 0.85 |

Based on above four eye movement indexes analysis, it can be found, when viewed different emergency scenarios pictures, students could be quickly note the risk area of pictures and improper emergency response area, this indicates they have some recognition capabilities and high degree of alertness in emergency scenes. When students need to make emergency response decisions, they chose to look at the correct emergency response area in the first reaction. it indicates students have a certain sense of emergency. but they inclined to concentrate on improper emergency response, it shows most college students can be aware of the dangers caused by improper reactions.

D. eye movement feature and emergency capability analysis

This article study college students' ability to identify and dispose danger in different emergency scenarios. Therefore Time to First Fixation is the most analysis value index in eye movement parameters. By analyzing the Time to First Fixation, we can obtain objectively participants' ability to identify danger. To study participants' emergency disposal capability is to analyze reactions made by students in different emergency scene.

By analyzing Time to First Fixation of students seeing different emergency scenes and counting subjects' personal information including sex and whether experienced crisis events or learned emergency knowledge. We can study the relationship between different individual movement characteristics and emergency capability.

- Eye movement characteristics of students with different emergency levels and emergency capability.

Keep all other variables constant, by comparing Time to First Fixation of students with different emergency levels. It shows Average Time to First Fixation of students who didn't receive emergency education is 1.01s, however who were trained emergency education is 0.73s when watched dangerous area, this shows students who received emergency education have strong hazard identification ability. By the following intuitive heat map can be obtained the same conclusion.



Figure 2 the heat map of not receiving emergency education



Figure 3 the heat map of receiving emergency education

- Different gender students' eye movement feature and emergency capability

Keep all other variables constant, compare Time to First Fixation of different gender students who saw hazard area of different emergency situation pictures. It turns out Average Time to First Fixation of male students is 1.12s, female students is 1.08s. Through eye movement trajectories comparison as Figure 4 and Figure 5, college students' emergency abilities are no significant differences in gender.



Figure 4 female gaze plots

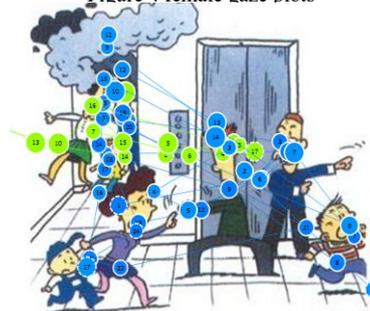


Figure 5 female gaze plots

IV. Results and discussion

A. Results

This study based on eye movement experiment mainly analyzes the emergency response capability of college students. According to eye-physiological indicators to measure students' reaction to face crisis events. The ultimate goal is to evaluate their emergency response capacities by analyzing different gender and different emergency levels student' eye movement indexes when they watched different emergency scenarios AOI, results as follows:

First, analysis of eye movement indexes, for example Time to First Fixation and Total Fixation Duration and Total Visit Duration and Visit Count, especially data of

Time to First Fixation suggests that most participants more pay attention to danger area when viewing different emergency scenarios pictures. It is further assumed that most students have strong hazard identification ability. Related to their options to emergency response, Time to First Fixation of right emergency response area earlier than improper emergency response area. It describes that subjects have some emergency disposal ability and can make right emergency response decision. But others eye movement parameters indicate students more inclined to look improper emergency response area, it is assumed that improper emergency response can cause the attention of college students who have certain estimate ability to results caused by risk behavior.

Second, as shown in visual heat map and gaze plots, students more focus on the inappropriate emergency response area, this explicates that most subjects are able to aware of the consequences caused by improper reaction, therefore they would generate high alertness in emergency situation. However their fixations relatively dispersed when viewing pictures containing the correct emergency response.

And third, by analyzing relationship between eye movement of individual student from different background and emergency capability by grouping, it turns out that students received emergency education have more hazard recognition abilities than those no trained emergency education, and more alertness, better emergency disposal capacity. However, gender factor is no significant difference in emergency response test and emergency ability.

B. Discussion

As discussed earlier in this paper, to improve students' emergency capability, at first, students should pay attention to cultivation of early-warning capacity. Universities should pay much attention to the usual scenario and improve their prevention ability, at the same time develop their unique sensitivity awareness in usual, and let them well analyze the external environment where they in and perceive campus potential risk from all angles. So they could learn microscopic trends related campus crisis scene and acutely aware of the various changes in the environment, they could take timely effective measures to avoid disadvantages in unfavorable environment. Next, colleges should carry out emergency drills and develop students' emergency capability. Students could become the ones who can hand a variety of crises by joining practical training and simulation exercises how to deal with crises. If crisis happen unfortunately, students also know how to quickly apply the survival skills and get away from danger in the context of crisis. Finally, students should be cultivated adaptability after crisis events. When students experienced a variety of different types of crisis events, they should be guided and inspired to self-summary, through each student's presentation and description, recalling crisis evolution from beginning to the end and franking their spiritual path, students could store emergency knowledge and skills. It is good for students to adapt to crisis process and repair the pains crisis brought. College guide students rely on their own mental ability to adapt and learn to deal with emotions to correctly treat with crisis events. Universities should take psychological and mental health education as an important part for cultivating students' comprehensive ability, thus it is benefit for students to correctly treat the damage caused by the crisis, at the same time, contribute to their healthy growth.

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The Analysis of CNC Spindle Temperature Field Based on Ansys

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Abstract—By taking the spindle system of high speed and high precision machining center as the research object, the finite element method is used to make the thermal analysis and the thermal-structure coupling analysis. In this paper, the heat dissipating capability of cooling system of spindle system is simulated and the thermal deformation is predicted. The result of simulation can provide reference for the solid design of spindle system.

Index Terms— spindle system, finite element method, thermal analysis, thermal deformation

I. INTRODUCTION

With the development of manufacture technology towards high precision, high efficiency and high automation, the thermal deformation control of machine tool in process has become a key issue to ensure the precision of machine tool. The thermal deformation is the expansive deformation of the components of the machine tool caused by the heat which is produced by friction and movement in working process of machine tool, it is the mainly embodies of thermal deformation of the technology system.

The machine tool is affected by many kinds of heat sources in working process and the heat is transferred to the machine tool by different ways. In working process, the heat resources which affect the processing precision can be divided in two categories, the first is internal heat resources and the other is outside heat resources^[1, 2]. The practice shows that the internal heat resources are the main reasons which cause the thermal deformation, which include cutting heat and the heat which is caused by internal friction.

The spindle system is an important component of machine tool and the thermal deformation error of the spindle system is the important factor which causes thermal deformation error of machine tool. Therefore, the thermal characteristic analysis and design of the spindle system is very important to ensure the precision of machine tool and is the key technology of high speed and high precision machine tool.



Figure 1. Solid model of the spindle system

In this paper, the designed spindle system of machining center mainly includes spindle, sleeve with cooling system, bearing and other accessories such as distance sleeve and so on, which is shown in Fig 1. The main heat source of spindle system is friction heat caused by spindle and bearing, the higher is the rotative speed of the spindle, the bigger is the thermal value and the heat dissipation mode is to bring the heat by coolant in the cooling system with convection heat transfer. The finite element method is used to simulate the bearing heating and the temperature distribution and result of thermal

deformation is obtained by analyze steady state analysis, thus guides the design of spindle system.

II. FINITE ELEMENT MODELLING AND ANALYSIS OF THE SPINDLE SYSTEM

Finite element modelling

First, the solid model of spindle system is built by using Pro/E and the structure which has no effects on the analysis result such as thread hole, keyhole, chamfer, fillet and so on are simplified. Considering the high rotational speed of spindle, the ball in bearing can be replaced by a circular ring with constant cross section. Importing the simplified solid model to ANSYS, the Solid70 element of ANSYS and the free meshing method are adopted. The finite element model is shown as Fig 2.

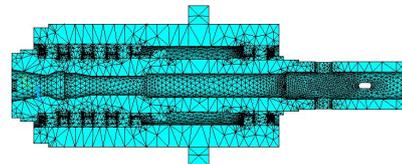


Figure 2. The finite element model of spindle system

The thermal analysis of spindle system

The emphases of thermal characteristic analysis using finite element method are the determination of heat source, heat transfer type and heat transfer coefficient. Because the motor of spindle of this machining center is far away from the spindle, the effect of motor heat on spindle can be ignored. The cutting heat is taken away by coolant and chip, the main heat source is the friction heat of bearing. The thermal transfer types needed to be considered are the forced convection heat transfer of coolant in sleeve and the forced convection heat transfer caused by the flow of the air around spindle. The thermal value of rolling bearing is calculated by the following equation:

$$Q = 0.105 \cdot 10^{-6} M \cdot v \quad (1)$$

Q is the heat (KW), M is the friction torque (N·mm) and n is the speed (r/min).

The friction torque is calculated by the following equation:

$$M = M_0 + M_1 \quad (2)$$

M₀ (N·mm) is the friction torque which is related with lubrication, it is shown as follows:

$$M_0 = f_0 \times (yn)^{2/3} d_m^3 \quad (3)$$

M₁ (N·mm) is the friction torque which is related with load, it is shown as follows:

$$M_1 = f_1 \times p_1 \times d_m \quad (4)$$

d_m is the mean diameter, f₀ is the lubrication factor of bearing, γ is the kinematical viscosity of lubrication, f₁ is the load factor of bearing and P₁ (N) is the calculating load which can determinate the friction torque.

The forced convection heat transfer is mainly considered heat transfer type in this paper. The law and effect of heat transfer of different flow pattern of fluid is

different, the different empirical formulae are used to calculate the heat transfer coefficient. The Reynolds number (Re) is calculated to judge the flow pattern, then, the empirical formula is selected. Re is regarded as the criterion which can judge the fluid is laminar or turbulence, and it is dimensionless.

Re of coolant in sleeve is calculated by as follows^[4]:

$$Re_c = (u \cdot D) / \nu \quad (5)$$

D is the size of geometric feature (m), u is the velocity of fluid (m/s), ν is the kinematical viscosity (m²/s).

Re of air is calculated by the following equation:

$$Re_c = (\omega \cdot d_s^2) / \nu \quad (6)$$

ω is the angular rate of the spindle (rad/s), ν is the kinematical viscosity of air (m²/s) and d_s is the equivalent diameter (m), which is shown as follows:

$$d_s = (d_1 l_1 + d_2 l_2 + \dots + d_n l_n) / l, l = l_1 + l_2 + \dots + l_n \quad (7)$$

l_i (i=1, 2, ..., n) is the length according to different diameter d_i (i=1, 2, ..., n).

In this spindle system, the coolant is water, the diameter of cooling hole is 8mm, the flow of coolant is 0.625l/min, the temperature is 25 centigrade and the speed of spindle is 8000r/min. The result of calculation is Re of coolant is 0.165×10^4 and Re of air is 2.92×10^5 . Re of coolant and air are both more than the critical value of the steady state. According to literature [4], correlation equation for the forced convection heat transfer of steady state is shown as follows:

$$Nu = C \times Re^n \times Pr^m \quad (8)$$

$$\alpha = (Nu \cdot \lambda) / D \quad (9)$$

Nu is the Nusselt number, Pr is the Prandtl number of fluid, α is the coefficient of convection heat transfer and λ is the thermal conductivity of fluid.

Nu of the coolant in sleeve is calculated by the following formula^[4]:

$$Nu_c = 0.023 \times Re^{0.8} \times Pr^{0.4}$$

Nu of air is calculated by the following formula^[5]:

$$Nu_a = 0.133 \times Re^{2/3} \times Pr^{1/3}$$

All the results are shown in Table 1.

TABLE I
THE CALCULATION RESULTS

| | Q of the front bearing (W) | Q of the rear bearing (W) | of coolant (W/m2.K) | of air (W/m2.K) |
|---------|----------------------------|---------------------------|---------------------|-----------------|
| results | 2045.6 | 325.2 | 1401.2 | 186 |

The heat of bearing is used to treat the essential boundary in condition in the form of heat generation rate. The comparative analysis of spindle with cooling system and spindle without cooling system is made to ensure the designed spindle system satisfy the practical needs. At the room temperature, the temperature field distribution of spindle without coolant is shown in Fig. 3. The highest temperature appears at the front bearing end, because the front bearing is angular contact ball bearing and the heat is bigger, the highest temperature is 29.84 °C and the biggest temperature rise is 4.84 °C.

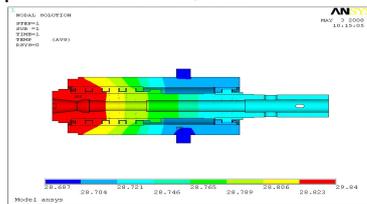


Figure 3. Temperature field distribution of spindle system without coolant

Under the same condition, the temperature field distribution of spindle with coolant is shown in Fig. 4 and the temperature field slightly decreases comparing with the spindle system without coolant. The highest temperature is 27.212 °C, and the biggest temperature rise

is 2.212 °C which is decreased by 2.628 °C comparing with the spindle system without coolant. The coolant has a good effect on heat dissipation of spindle system.

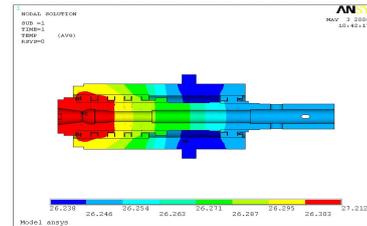


Figure 4. Temperature field distribution of spindle system with coolant

III. THERMAL-STRUCTURE COUPLING ANALYSIS OF THE SPINDLE SYSTEM

The above two temperature field distribution is regarded as load and the thermal-structure coupling analysis of spindle system is made. The nephogram of thermal deformation of spindle system without coolant is shown in Fig. 5-Fig. 7, the biggest deformation in radial direction is 0.0126mm and 0.0767 in axial direction, the synthetic deformation is 0.771mm. The nephogram of thermal deformation of spindle system with coolant is shown in Fig. 8-Fig. 10, the biggest deformation in radial direction is 0.00859mm and 0.0521mm in axial direction, the synthetic deformation is 0.0524mm. The deformation of spindle with coolant is smaller.

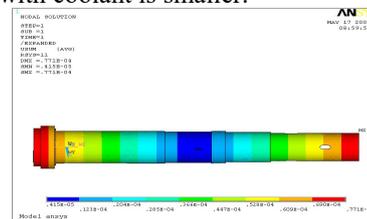


Figure 5. Synthetic thermal deformation of spindle system without coolant

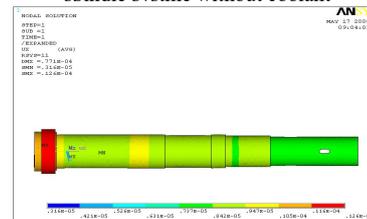


Figure 6. Radial thermal deformation of spindle system without coolant

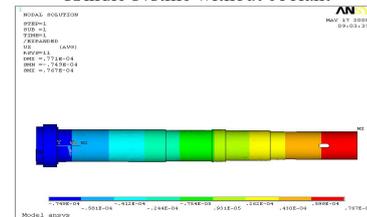


Figure 7. Axial thermal deformation of spindle system without coolant

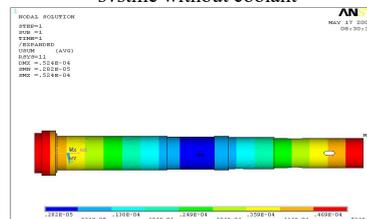


Figure 8. Synthetic thermal deformation of spindle system with coolant

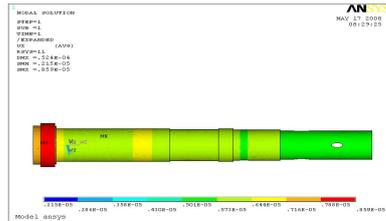


Figure 9. Radial thermal deformation of spindle system with coolant

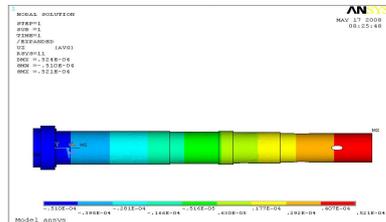


Figure 10. Axial thermal deformation of spindle system with coolant

III. EXPERIMENTAL VALIDATION

The data acquisition experimental of temperature field and thermal deformation is carried to better understand the change of temperature field and the thermal deformation of spindle in practical situation and verify the reliability of analysis result. The spindle is free running on the rotational speed of 8000r/min and the sampling period is 5 minutes at room temperature. References are cited in the text just by square brackets [7].



Figure 11. Example of a figure caption



Figure 12. Data acquisition interface

The measuring system is composed of 8 intelligent temperature sensors DS18B20, a development board based on 89C51 chip, serial port line and computer. The distribution of temperature sensors is shown in Fig. 11. Generally, the more the sensors, the more the measuring system could reflect an actual situation of temperature field. Considering the actual structure of the spindle of the machining center, the 8 sensors are installed on the spindle at equal distance. The first sensor is located at the front bearing and the last sensor is located at the rear bearing, the sensors can reflect the change of temperature of the whole spindle. The temperature data obtained by the sensor DS18B20 is transferred to computer real-time by the development board and serial port line and the data is stored in the computer to process the data later. The data acquisition interface is shown in Fig. 12.

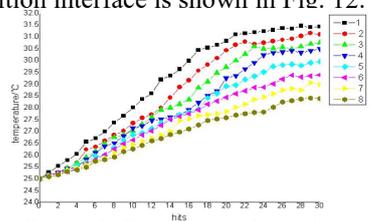


Figure 13. Temperature of the spindle

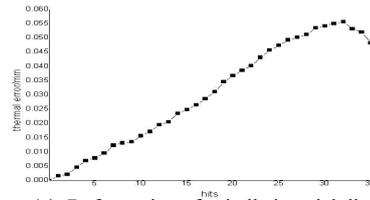


Figure 14. Deformation of spindle in axial direction

Every sensor selects 30 values of temperatures every 5 minutes. Then, the deformation in axial direction is measured. The biggest temperature rise appears around the front bearing which is proved to be the biggest heat source, as shown in Fig. 13. It is the same as the analysis result. In initial stage of experimental, temperature changes greatly, then the change of temperature becomes flat. The temperature of front bearing gets the highest temperature first and the farther from the heat source, the more slowly the temperature rises. The biggest error in axial direction is 0.0556mm, as shown in Fig 14, and the biggest error does not appear at the highest temperature but appears a period of time after reaching the highest temperature.

IV. CONCLUSION

In this paper, a high speed and high precision machining center is taken as the research object. The finite element analysis method is adopted to make the thermal analysis and the distribution of temperature field and the thermal deformation are predicted effectively. In the experimental, the data of temperature field and axial error are captured according to the actual processing situation. The results prove the reliability of the finite element analysis which can provide reference for design of spindle system and thermal error compensation.

ACKNOWLEDGMENT

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Analysis and Apply of Static Elasto-Plastic Method –Example of Shifang Telecom Building under Wenchuan Earthquake

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Abstract—This paper analyses Shifang telecom building which suffered from the Wenchuan earthquake applying elasto-plastic method, investigates the deformations ,internal forces ,and damage patterns of the structure under the rare earthquake, compares with the different loading patterns of the structure ,then seismic resistance of the mode is also evaluated, at last makes the recommendations of the seismic retrofiting. By finite element software SAP2000, we can get intuitive and in- depth understanding of static elasto-plastic method ,and can link the theory with practice, then transplant the calculating method to more complicated seismic design.

Keywords—static elasto-plastic method, plastic hinge, rare earthquake, loading pattern

I INTRODUCTION

The basic principle of China's National Seismic Design Code for Buildings[1] is non-failure in minor earthquake, fixable in medium earthquake, and non-collapse in major earthquake, while the design is divided into two phases based on the principle, i.e. conduct structural strength design for common seismic, and conduct structural ductility design for rare seismic. Regarding the structural strength design, the current method in practice includes bottom shearing method, vibration model analyzing response spectrum method, and the time-history method. Regarding the structural ductility design, there's only simple introduction on the iterative calculation on the time-history method, but no compulsory requirements available. With the fast developing of computer science, and the structural is becoming more complicated day after day, the structural ductility design turns as necessity, especially due the high frequency of earthquake in China.

Static elastic-plastic method (Push-over) is an important method in solving the ductility analysis under rare earthquakes. There's clear regulation in China's Seismic Design Guideline that the method can be adopted when calculating the elastic-plastic deformation of the structure's weak section under rare earthquakes. However, the method and theory is abstract, and there's no direct and clear impression for users.

The paper will focus on the above mentioned calculation method and the characteristics, and take the case of Shifang Telecom Building as an example to explain the elastic-plastic calculation under rare earthquake, with the assistance of SAP2000, so as to make clear the concept and reach a deep understanding of the method and the application in engineering.

II. STATIC ELASTO-PLASTIC METHOD AND APPLICATION

Static elasto-plastic method is a static nonlinear calculating method in nature, and its characteristic is leading the design response spectrum into the engineering calculating. This method adopts the simple mechanical model instead of real structure, then imposes the lateral monotone increasing load to the model to get the target displacement. Last study the weakness of structure and its nonlinear response to decide whether the capacity of structure will meet the demands of building function under the rare earthquake in the future.

At present, static elasto-plastic method has two applications:

(1) By the Static elasto-plastic method, we can get the structure capacity curve, and transfer this curve into the capacity spectrum, at last get the target displacement combined with the demand spectrum. Push the structure to the target displacement, then inspect the property of structure to achieve the seismic design based on capacity.

(2) After get the target displacement, push over the structure, at the same time record the periods after appearing new plastic hinges every time, draw the curve with the periods and seismic influence coefficient, then compare with the seismic design response spectrum to evaluate the seismic capacity of structure.

III.SETTING PLASTIC HINGE OF FRAME STRUCTURE

There are four types of plastic hinges which is moment hinge (M), shear hinge (V), axial force hinge (P) and press bending hinge (PMM) which can be set whatever needed of frame element. The constitutive relationship of plastic hinges are shown in Fig.1. In the fig.1, Y-axis represents moment, axial force, shear force and X-axis represents all kinds of deformation. The curve incudes four stages: elastic stage (AB), hardening stage (BC), unload stage (CD) and plastic stage. SAP2000 provides two types of methods which can define plastic hinge: one is plastic hinge is defined by user, another is defined by American code "FEMA27"3 and "ATC-40".[2][3][4]

IV STRUCTURE TARGET DISPLACEMENT AND PERFORMANCE POINT

Base on the Chinese "Code for seismic design of building", inter-storey displacement angel value of the reinforced concrete frame construction is 1/50, then the structure target displacement which is lateral displacement of the top storey is 1/50h, among the formula, h is floor height of frame structure. According

to the experience, when the displacement of the top storey get the target displacement, the members of the structure tend to destroy, and this moment is the sign of destroy as static-elasto plastic analysis .

Base on the determination method about the performance point in “ATC-40” and the elastic response spectrum in Chinese code, we can get the station of performance point under the minor earthquake, middle earthquake and rare earthquake. The station of the performance point is related to parameter C_a and parameter C_v . in curve of spectrum. The transformation relation of C_a , C_v between the American code and Chinese code is below:

$$\eta_2 \alpha_{\max} = 2.5 C_a \tag{1}$$

$$\left(\frac{T_g}{T}\right)^r \eta_2 \alpha_{\max} = C_v / T \tag{2}$$

Transfer above two formulas to formula (3) and (4)

$$C_a = \eta_2 \alpha_{\max} / 2.5 \tag{3}$$

$$C_v = \left(\frac{T_g}{T}\right)^r \eta_2 \alpha_{\max} T \tag{4}$$

V ENGINEERING PROJECT

STB is a reinforced concrete frame structure locating in the center of Shifang city, which is built in early 1980s. The total area is 2300m², containing office and a bell tower. The office section is five-storey, with few four-storey and bell tower sections nine-storey. Furthermore, the equipment mass on the 7th, 8th, 9th floor is 6 ton and the top steel tower is 10 ton. Fig. 2, 3 show the layout and elevation of the building.

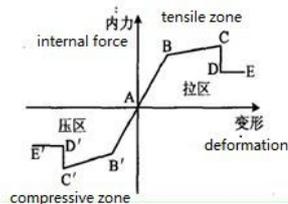


Fig.1 constitutive relationship of plastic hinge

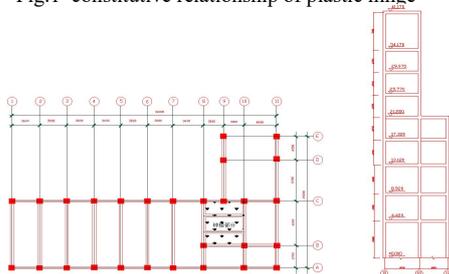


Fig.2 Layout of the structure Fig.3 Elevation of the structure

Referred to related data, the building is C-class, with seismic fortification intensity 7 degree, design basic acceleration of ground motion is 0.10g (adopt amended value 0.15g when making seismic retrofitted evaluating), the ground is II-class, and the design earthquake classification is second. Under this Wenchuan earthquake, STB caught some damages in beams and columns on the 6th and 7th floor in the bell tower. Among these damages, there are some concrete cover

peeling off, and others presented plastic hinges at the end of the beam and columns, as shown in Fig.4 (a), (b).



(a)Damage of beam (b)Damage of column
Fig.4 Seismic damage in the bell tower

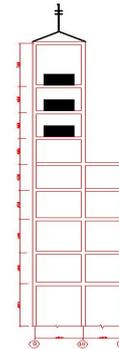


Fig.5 Analytical model

This paper study the seismic performance of the structure and failure mechanic under the rare earthquake by the static-elasto plastic analysis to find the weakness of the structure and prove the truth.

A. Static-elasto plastic analysis

This paper set up analytical model with the steel tower and the equipment in Fig.5 with software SAP2000 developed by American CSI corporation. Base on the parameters of STB, $T_g=0.40s$,damping ratio is 0.05, then $C_a=0.2, C_v=0.2$.

Loading cases

During the analytical process, the first step is to impose the representative value of gravity load; the second step is to impose lateral forces of x or y direction based on internal force & deformation in the first step. The loading cases of static elasto-plastic are shown in table.1.

TABLE.1 LOADING CASES OF STATIC ELASTO-PLASTIC ANALYSIS

| Case | Direction Explaining | Loading cases |
|------|----------------------|---|
| 1 | x | uniform acceleration |
| 2 | y | uniform acceleration |
| 3 | x | mode shape 1of x direction |
| 4 | x | mode shape 2of x direction |
| 5 | y | mode shape 1of y direction |
| 6 | y | mode shape 2of y direction |
| 7 | bi-direction | uniform acceleration($\alpha_x : \alpha_y = 1 : 0.85$) |
| 8 | bi-direction | uniform acceleration($\alpha_x : \alpha_y = 0.85 : 1$) |
| 9 | x | SRSS combination of mode shape 1 of x direction and mode shape 2 of x direction |
| 10 | y | SRSS combination of mode shape 1 of y direction and mode shape 2 of y direction |

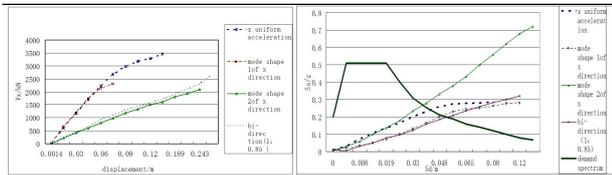
Performance point and earthquake response.

Firstly, transform the response spectrum curve into spectral acceleration-spectral displacement curve, then set the above mentioned curve and capacity spectrum curve into the same coordinates, as shown in Fig 6, 7, which shows that intersection of curves is within linear elasticity limit of the capacity spectrum curve. According to table.2 that lists all parameters, control point of model

is within the limit; the base shear of performance point value is less than the maximum value of base shear. Thus we can conclude the model's ductility is good.

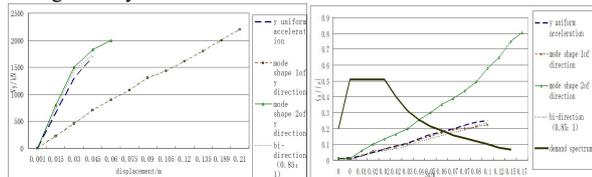
TABLE. 2 PERFORMANCE POINT VALUE AND RESPONSE UNDER RARE EARTHQUAKE

| Case | Performance point | | Displacement on control point | | V base shear | |
|------|-------------------|-------|-------------------------------|-------------|-----------------------|--------------------|
| | Sd/m | Sa(g) | Δ /m | Δ /H | Performance point(KN) | Maximum value (KN) |
| 1 | 0.036 | 0.230 | 0.070 | 1/603 | 2517.38 | 3418.58 |
| 2 | 0.050 | 0.170 | 0.032 | 1/1319 | 1360.70 | 1710.27 |
| 3 | 0.053 | 0.152 | 0.039 | 1/1082 | 1488.39 | 2275.29 |
| 4 | 0.050 | 0.258 | 0.066 | 1/639 | 879.60 | 2070.15 |
| 5 | 0.052 | 0.158 | 0.117 | 1/361 | 1550.01 | 2197.36 |
| 6 | 0.039 | 0.258 | 0.017 | 1/2482 | 879.60 | 2123.09 |
| 7 | 0.048 | 0.184 | 0.160 | 1/264 | 1857.55 | 2620.43 |
| 8 | 0.055 | 0.155 | 0.030 | 1/1406 | 1429.57 | 1712.54 |
| 9 | — | — | 0.077 | 1/535 | 1728.23 | 3075.80 |
| 10 | — | — | 0.118 | 1/349 | 1782.19 | 3055.15 |



(a)related curve of Base shear-displacement of performance point(b)performance point

Fig.6 Analysis result of model B in x direction



(a)related curve of Base shear-displacement of performance point (b)performance point

Fig.7 Analysis result of model B in y direction

Fig.6, 7 shows that computed result by means of capacity spectrum is related to different kinds of horizontal loading cases. As we are making static elasto-plasticity analysis, besides the characteristic of loading case itself, asymmetry of structure and disproportionation of longitudinal rigidity are contributing to different results, so according to these special structures, it is necessary to adopt different loading cases.

B. Inter-storey elasto-plastic drift ratio

There are inter-storey elasto-plastic drift ratio of the model under bi-earthquake shown in Fig.8, 9. Regarding to the model with the steel tower and equipment set in the bell tower, rigidity increases, there is a sudden change of inter-storey displacement angel in the 6th and 7th floor, the maximum value of the inter-storey displacement angel is 1/66.6 ,still within the limit 1/50.

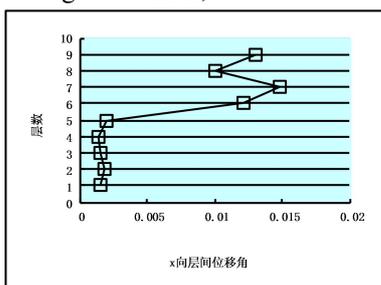


Fig.8 Inter-storey x drift ratio under the last elasto-plastic analysis case

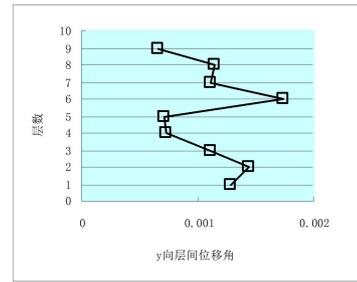


Fig.9 Inter-storey y drift ratio under the last elasto-plastic analysis case

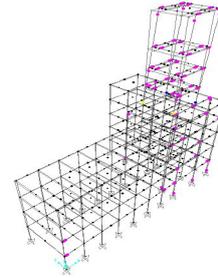


Fig.10 Plastic hinges distribution of the models under the last elasto-plastic analysis case

C. Plastic hinge distribution under rare earthquake

As the model has equipment and steel tower, rigidity of structure has a sudden change from the 6th to 9th floor. While in maximal pushover stage, the structure has a sudden change of rigidity in longitudinal direction. There are intensive plastic hinges in beams and columns from the 7th to 9th floor, most of them are in yield stage, and the less is in limit stage, as shown in Fig.10. The above conclusions are in accordance with the reality.

5 CONCLUSION

On basis of the engineering analysis, we come to the following conclusion:

(1) There is intersection of capacity spectrum curve and demand spectrum curve under different loading cases for model A and B. The displacement of control points is less than limit so far.

(2) The model shows that there are intensive plastic hinges of beams and columns in the bell tower, just the same as the reality. Though steel tower on top amplifies the response of structure indeed, the structure can meet the requirements of non-collapse under rare earthquake.

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Central Air-Conditioning Energy-Saving Intelligent Group Control System

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Abstracts—For a branch of People's Bank of China original central air conditioning non-intelligent control and not energy deficiencies, energy-saving central air-conditioning intelligent group control system is designed based on GSM network. System selection using PLC, with temperature sensors and intelligent electric valve control out of the water, using Siemens WinCC human-machine interface touch screen design, implementation sets the parameters of central air-conditioning control systems and remote Smart Start, and finally realize the central through GSM network remote data transmission air conditioning running. The user can use the phone or computer terminal to monitor the entire system. By running show that the system can realize remote monitoring and intelligent control, with good energy efficiency.

Key words—Central air-conditioning; GSM; intelligent group control; energy control

I. INTRODUCTION

With the building of increasingly large, central air-conditioning applications are increasingly widespread. Conventional central air conditioning for industrial site management to decentralized control-oriented, has been unable to adapt to the people of residential, office and other environmental comfort increasingly higher demands. With the advent of intelligent buildings for the realization of space management and central air conditioning unit segmentation and time synchronization, while reducing administration costs and air conditioning energy consumption, network control air conditioning system has become a trend, the domestic literature reports based on Android mobile phones and wireless central air-conditioning remote data monitoring system sensor networks [1-2]. Foreign Chuzo Ninagawa such as the development of the air conditioning remote control system architecture based network server link communication technology [3], Du Haicun and other embedded technology in central air conditioning systems and high-end centralized control [4]. The monitoring system to achieve intelligent building requirements, but networking is more complex, more expensive equipment, and less energy-saving factors considered. Since the GSM network technology has convenient, high reliability advantages, it is widely used in data communications industry [5].

In this paper, the intelligent energy-saving central air-conditioning as a branch of People's Bank of China Project, proposes energy-saving central air conditioning intelligent group control system based on the GSM network, the frequency transformer technology embedded into the control system, via GSM wireless communications, management personnel centralized monitor the temperature, frequency and other parameters of central air conditioning running while the data collected in the host computer for real-time display and storage. The entire central air-conditioning system can be automated, network management, low-cost and energy-

saving purposes. After analysis of the actual operation, the output parameters to meet the requirement, save manpower, material and financial resources.

II. SYSTEM STRUCTURE AND WORKING PRINCIPLE

The energy-saving central air-conditioning intelligent group control system by the monitoring platform and the control cabinet terminal configuration, the original air-conditioning system transformation was complete. The original system power parameters: 18kW of cooling water pump 3 sets; 15kW of chilled water pumps 3 sets; 5.5kW cooling fan 2, the control mode to manual and no monitor, engineered to increase content. The new control cabinet terminals, the original control cabinet and the new control cabinet switching operation with each other. After transformation, the system block diagram in Fig 1.

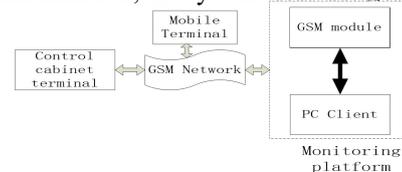


Fig.1 Saving group control system block diagram

Control cabinet by Siemens CPU226 main terminal and touch screen, GSM module, external expansion modules EM223, EM221 and EM231, Schneider LC1-D3201 C65D AC contactor and circuit breakers, relays Omron MY-4J, EDS1000-4T-0150P can easily drive Guangzhou Kitazawa electric switch flange DN100 butterfly valves and other electrical components, control cabinet terminal block diagram shown in Figure 2.

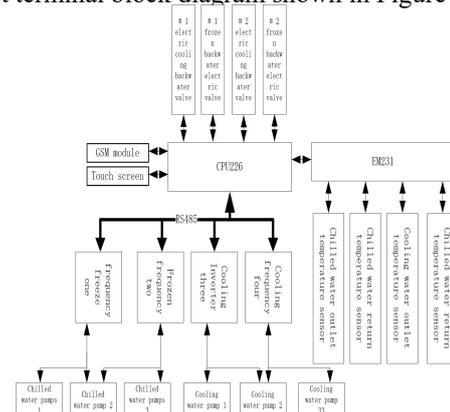


Fig.2 Control cabinet terminal system structure diagram

Temperature sensor detected temperature signal EM231 module directly into digital signals stored in the PLC register, intelligent electric valve status is displayed on the man-machine interface. Inverter and PLC with RS485 bus in the form of communication, PLC real time to read the information of the parameters the drive is running and timely adjust the frequency of the inverter, changing the cooling pumps and refrigeration pump speed to change the water flow to achieve indoor temperature regulation and power reductions while controlling GSM module various data acquisition in real-

time to send a text message to the monitoring platform. Phone systems and management personnel to achieve two-way communication, real-time data can be read phone system is running, remote control can start and stop the entire air conditioning system.

III. HARDWARE DESIGN

A. PLC central processing unit

Use Siemens CPU226 as a controller, with the Siemens external expansion modules EM223, EM221 and EM231 and 6AV6 648-0BC11-3AX0 touchscreen [6], the controller features a 12-bit A / D converter module, to facilitate the acquisition of the analog signal conversion a digital signal, the output of the primary control various relays and contactors.

B. Temperature Sensor Modules

Temperature sensor Pt100, measuring range: -50-300 °C , the host cooled and frozen into place into the backwater at each place two temperature sensors, placed a total of two hosts eight temperature sensors for real-time monitoring of each pipe temperature and displayed on the touch screen. EM231 module with temperature sensor, wiring is simple, requires no external signal conditioning circuitry.

C. The drive module

18KW inverter using EDS1000-4T-0150P can easily drive, which drive functional, for a variety of on-site supporting the use of constant pressure drag more than one control, and built-in RS485 communication interface, enabling centralized control and master gearing control [7]. In this system, PLC and inverter with RS485 communication, read the inverter common parameters such as current, voltage and frequency is sent to the control center via GSM module.

D. GSM module

GSM module TC35i, this module is Siemens company to meet all production areas of wireless communications, voice transmission needs based on the development of a mobile communication network system products, and integration of standard RS232 interface and SIM card, receive information via PLC resolve after the data, immediately interrupt, set according to interrupt data processing. System requires the transmission of digital text, so use Text Mode [8].

IV. SOFTWARE DESIGN

The system software design includes: PLC main program design, WinCC interface design, GSM module programming.

A. PLC main program design

Fan and pump loads: motor speed n, the flow rate Q, the relationship between the head and shaft power P H is:

$$\frac{Q_1}{Q_2} = \frac{n_1}{n_2}, \frac{H_1}{H_2} = \left(\frac{n_1}{n_2}\right)^2, \frac{P_1}{P_2} = \left(\frac{n_1}{n_2}\right)^3 \tag{1}$$

Tab1 SMS data frame format

| Frame start Identifier | Frequency Start character | Frequency | Frequency Terminator | Temperature Start character | Temperature values | Temperature Terminator | End frame Identifier |
|------------------------|---------------------------|-----------|----------------------|-----------------------------|--------------------|------------------------|----------------------|
| MSG | Fre | X | Fre | Tem | T | Tem | END |

GSM Communication Process Design

Formula (1) n_1 , as a motor speed; Q_1 , Q_2 for flow rate; H_1 , H_2 for the head; P_1 , P_2 shaft power.

By the formula (1) that the flow rate, head and shaft power are proportional to the rotational speed, the rotational speed of the square and cube.

Main program flow shown in Figure 3, when the system starts to initialize the serial port, interrupt, Drives, set by WinCC flexible software PID parameters self-tuning, scaling parameter P = 1, the integral parameter I = 5, differential parameter D = 0 [9]. Whenever the PLC after receiving a set of data automatically generate an interrupt request, the interrupt service routine, set the flag M0.1 set, indicates that allows the interrupt service, in the main program by detecting the state of M0.1 to determine whether the message is received and decoded into, promptly after the completion of the received data flag M0.1 is reset. Upload PLC data is uploaded according to a communication protocol format. When the system enters the automatic operation, the electric valve to open and read the CPU communicate with the drive after each duct temperature sensor to automatically adjust the PID, read and write operations are within the PLC scan cycle is complete, the response of the system in real time.

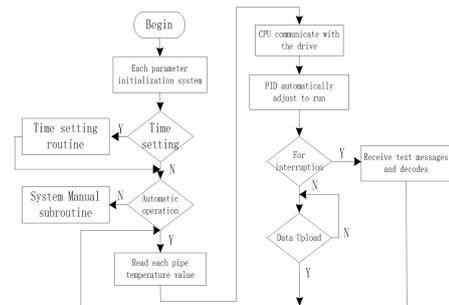


Fig.3 PLC main program flow chart

B. Touch Screen Design

Touch-screen system is the use of Siemens WinCC (Windows Control Center) prepared. In the main interface, you can monitor the cooling water pump and chilled water pumps running, temperature and electric valve open state each temperature test points. Engineered a stop / start button, one button start-stop throughout the central air conditioning system to facilitate the management of on-site manipulation. The entire system without setting too complex statement, only set in the PLC register link.

C. GSM module programming Protocol

PLC is set to free the serial communications mode conversion interface module to communicate with the GSM through RS485-RS232. Control cabinet terminal form of text messages sent in Table 1 to the monitoring platform or mobile phone directly to the administrator. Wherein the frequency values comprises cooling and freezing pump frequency of the pump, the temperature comprises a temperature value of each pipe.

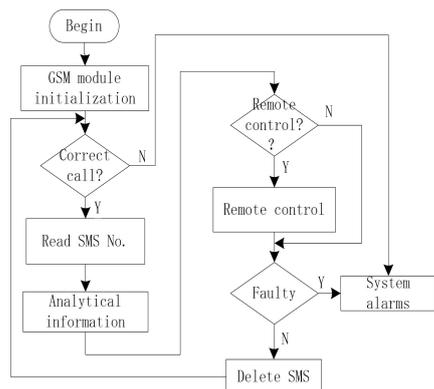


Fig.4 GSM communication flow chart

GSM communication includes inter-module and inter-module communication and module and mobile communications. AT command programming language, as shown in Figure 4, the first GSM module initialization, "AT + CNMI = 1,1,2 \ r \ n" is set to automatic SMS Echo mode; in order to save the cost of SMS, the control cabinet terminal number, the monitoring and management platform number five yuan mobile phone number to join the family net monthly package, unlimited number of text messages. After the addition is set to Text encoding mode and service center address, initialization is completed.

Actual operation system, PLC read register frequency, temperature and other parameters configured message frame format data is sent to the monitoring platform GSM module, monitoring the platform to determine whether the correct call number, if the message content is displayed directly on the computer terminal. When managers send phone commands such as "open system", the control cabinet terminal GSM module serial port after receiving the instruction to PLC "+ CMTI: 'SM' <number>", PLC is constructed AT read instruction reads SMS content, into the remote control program, remote opening system. Considering the mobile 4g SIM card can hold 150 messages, plus the "AT + CMGS = <x> \ r \ n" in the programming instructions to delete messages, SMS storage capacity to ensure adequate. If you receive an incorrect call number or system failure, the system sends an alarm signal.

V. CENTRAL AIR-CONDITIONING TEMPERATURE TEST

As can be seen from Figure 5, when the host computer is turned on, the system frequency operation 25 minutes into the PID automatic adjustment, the cooling water temperature is set 37 °C , adjust the time as 31 minutes, the overshoot of 6.23%, the error is 0.2 °C ; frozen backwater temperature setting 14 °C , adjust the time as 23 minutes, the error is 0.3 °C , the temperature of both the average error is 0.25 °C , after stabilizing indoor meet staff comfort. The entire system visible overshoot adjustment process in a reasonable range, moderate adjustment time, allowing the entire system rapidly enters the central inverter working condition.

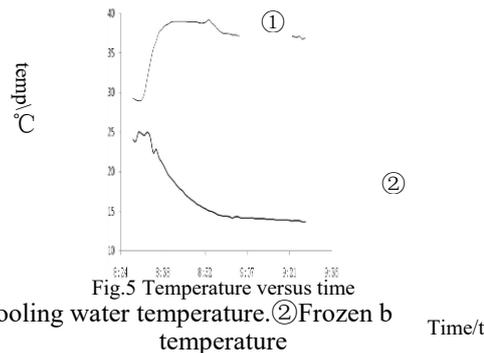


Fig.5 Temperature versus time

①cooling water temperature.②Frozen b temperature

VI. CONCLUSION

This system combines GSM network technology, the signal can cover the range of radius 35km, network convenience; by the temperature sensor to collect real-time temperature, PLC automatically adjust the pump speed and the switching operation of the number of pump monitoring platform to build fully automated central air conditioning system and control of one of. Start-stop system with remote control function as well as a good man-machine interface, has been put into use, more than six months of operation results show that the stability of the system performance, facilitate personnel management and control.

ACKNOWLEDGMENT

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Method for Handling Repeated SNMP Packets

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Abstract— This article proposes an method to solve the problem of repeated SNMP (Simple Network Management Protocol) request packets. The method is based on the principle of temporal locality. In this method firstly the source IP (Internet Protocol) and the Request-ID contained in the currently received SNMP request message is got. Different SNMP request packets received from the same source IP are uniquely marked by different Request-IDs. Then there will be a step of searching in an SNMP management control block by using the currently acquired source IP and Request-ID as indexes. The information item of the SNMP management control block stores the source IP and the Request-ID contained in previously received SNMP request message. If the currently acquired source IP and Request-ID is searched in the SNMP management control block, the currently received SNMP request packet will be discarded; if the information is not searched, the source IP and the Request-ID in the currently received SNMP request packet will be added to the SNMP management control block item. This method can effectively prevent network element equipment from being impacted when network management system sends the SNMP request message to the network element equipment under the condition that vast range and route loopback exit in a network. This method can also improve the efficiency of the network.

Index Terms—SNMP request packet, loopback, network efficiency

I. INTRODUCTION

IP (Internet Protocol) is the base technology of internet. More and more NE (network element) are based on IP. SNMP (Simple Network Management Protocol) is currently the most widely IP based protocol used to manage those network equipment^[1].

SNMP defines five types of PDU (Protocol Date Unit)^[2]. As shown in Figure 1, in particular:

- 1) get-request^[3]: sent by the NMS (network management system) to NE device to get information of NE;
- 2) get-next-request^[4]: sent by the NMS to NE device to get next information of NE;
- 3) set-request^[5]: sent by the NMS to NE equipment to change the value of a variable or list of variables of NE;
- 4) get-response^[6]: send from NE to NMS to response the get request;
- 5) trap^[7]: send from NE to NMS, used to notify certain events occur.

Among the above-mentioned five types of SNMP packets, the first three messages are sent by the MNS to the NE, the latter two messages are sent by the NE to NMS. Only trap messages are network elements initiate unsolicited information packets to the NMS to report a specific event, such as the equipment startup, shutdown, and other changes. By offering the five types of SNMP messages, SNMP offer following basic operations: access to network device information (Get: read), set the

network device parameters (Set: write) and event reporting (Trap: Trap operation).

There is an ID field in all the request messages set messages and response messages. The ID field is used to match requests and responses. Each request message has a globally unique ID. For outgoing packets from NMS, the ID will not be repeated in a short time.

If there are bracing and routing loops in network within the broadcast domain, the request or response packet will be bracing to all the network elements including gateway. In case the gateway receives the request or response message, it will again brace the packet to all network elements in the broadcast domain. Under this condition, messages will cycle in the network, NE will receive a lot of repeated SNMP requests (SNMP request packet source IP address and ID field are the same). To deal with a lot of duplicate requests, NE will be busy or even down.

II. DESIGN OF SYSTEM

This article provides an SNMP request packets processing method to prevent circle repeated SNMP request packets.

The SNMP request packet processing method comprising:

NE gets the current source IP and Request-ID from received SNMP request packet A. Different SNMP request packets received from the same source IP are uniquely identified by a different Request-ID. Then NE uses the source IP and Request-ID as an index to find in the SNMP management control block. The SNMP management control block is used to store SNMP information items. Each stored information item includes packet source IP and Request-ID of SNMP request. Besides the source IP and Request-ID, there are also a counter and a filed with the name 'used' in the SNMP information items. The counter record the time when the item is added or found be same with another SNMP request packet's source IP and Request-ID. The field 'used' indicates whether or not the item is in use.

In the SNMP management control block, there is an IP list. Each item in the IP list contains a SNMP information sub-list. All the SNMP information items mentioned above are stored in several sub-lists. Every item in same sub-list has the same source IP of request packet. The length of the IP list is n. The length of every SNMP information sub-list is m.

The SNMP management control block is showed as following in Figure 1.

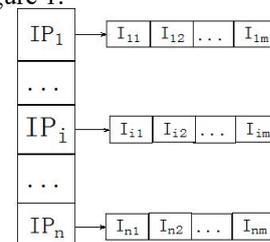


Figure1. SNMP management control block

In Figure 1, IP₁ stand for the first source IP received from SNMP request packet. And IP_i stand for number i source IP received from SNMP request packet. IP_i has a sub-list with the member I_{i1}, I_{i2}, ..., I_{im}. In which capital 'I' is for list item, and the 'i' in lowercase is for the number i source IP, and the 'm' is for the number m item in the sub-list.

The SNMP information item is showed as following in Figure 2:

| | | | |
|-----------|------------|--------------|------|
| source IP | request-ID | time counter | used |
|-----------|------------|--------------|------|

Figure2. SNMP information item

In Figure 2, the "used" field is 'TRUE' (a value of type of BOOL) when the item is in use, is 'FALSE' (a value of type BOOL) when the item is removed.

If the same source IP and Request-ID can be found in the SNMP management control block, it means that packet A is a repeated packet. Then packet A will be discarded. And the counter of the corresponding SNMP information item will be updated according to the system time. In another case if the same source IP and Request-ID can't be found in the SNMP management control block, it means packet A is not a repeated packet, and then packet A will be handled as a normal SNMP packet. And a new SNMP information items will be added to the sub-list of the IP list. The item includes the source IP and Request-ID of the packet, counter according to the system time and the field 'used' with the value 'TRUE'. If all the m items in the sub-list of certain IP is used, namely its' field 'used' are 'TRUE', the item with the largest 'counter' will be removed, and then the new item can be add to the SNMP information item sub-list.

There is an aging timer function block in the SNMP management control block. When the aging timer times up, each counters of the SNMP information items will be reduce the corresponding time. If a counter is lower than zero, the item contains the counter will be removed. If all the items in the sub-list of certain IP is not used, namely its' field 'used' are 'FALSE', the corresponding item in the IP list will be removed.

The process flow is showed as following in Figure 3:

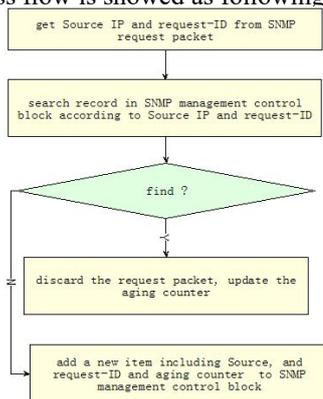


Figure 3 Process flow

III. IMPROVED RESULTS

This method has been verified using C language under VxWorks system. Under high test pressure system using the method proposed in this article can discard all the repeated SNMP request packets. System efficiency is greatly improved. And system without using the method proposed in this article often crash.

IV. CONCLUSIONS

The method proposed in this article can greatly improve the efficiency of an NE supporting SNMP protocol. And the method can reduce the risk of crash of NE. And good results have been achieved by using the novel method proposed in this paper.

VI. ACKNOWLEDGEMENTS

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Numerical Study of Power Plant Boiler Countercurrent Super Heater Heat Flowing

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Abstract—In this paper numerical simulation,taking the software FLUENT as computing tool , power plant boiler countercurrent super heater heat flowingwere simulated .The analysis of the simulation results can be divided into three parts , thatthe performace between the steam turbine and the boiler flue and parameters of the inner steam .The results shows that along the cabinet width, the temperature level peaked at both sides and it was low in middle ; the design of the box body, affects the quality of tube steam.The simulation results are very close to the normal operational conditions .This paper provides a certain reference value to the design of superheater.

Index Terms—Superheater;heat transfer flow;Numerical Simulation;Flue gas

number. Starting from the Z axis negative direction, sign the number-1,2,3. From the upper body to the pipe number in each row, followed by 1-8.The NO.1 is steam outlet pipe and NO.8 is the steam inlet pipe.;

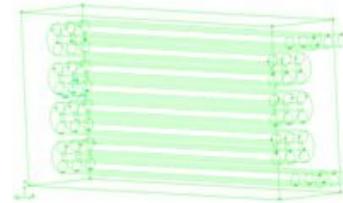


Figure 1 model of the superheater

I. FOREWORD

In the modern power plant boiler, the superheater is the main part. It uses the

the water vapor in the flue gas heating the tube heat exchanger, and the steam saturation temperature rise to overheating temperature . The temperature of the boiler furnace exit flue gas is high,can reach to 1000 °C - 1100°C.As a result , under the environment of high temperature and high pressure in a Long-term, the tube burst is often happened .And the "four tube" problem is most prominent, that is high temperature corrosion and wear of the station boiler water wall, superheater tubes, reheater tube, economizer tube, etc. These problems are destroyed the normal operation of the superheater, and affected the safety of the power plant, cause the economic losses of power plants. So the superheater tubes in heat transfer flow is of great significance.

In recent years, with the rapid development of numerical calculation technology and simulation theory, using the method of numerical calculation of superheater research more and more. In domestic , Jiang Ren Qiu, Li Yanjun through numerical simulation, concluded that the increase of gas pressure can cause smoke density increases and the heat transfer enhancement of superheate [2]r. In this article, through the FLUENT software in power plant boiler superheater upstream flow heat transfer numerical study, the optimization design for the future provide intuitive information[1].

II. THE STRUCTURAL CALCULATION MODE

A .the structural design of superheater

As the research objects are the internal space , external space, and flue gas steam tube wall heat transfer , So ignoring the superheater tube wall heat insulation board such as structure, leaving only shell and tubes. It mapped the physical model of superheater though the GAMBIT. Its structure is shown in figure 1. The model consists of three rows each tubes and each of rows has eight pipes. Define the X direction as the length, y direction for a row of tubes, z direction for the tube row

TABLE1 .SUPERHEATER GEOMETRIC PARAMETERS UNIT: MM

| Parameter | Superheater diameter | pipe range | length(x) | width (z) | Height (y) |
|-----------|----------------------|------------|-----------|-----------|------------|
| value | 42 | 1500 | 1750 | 300 | 600 |

B. meshing and boundary conditions

Heat exchanger model mainly divided into two parts: 1.the Cabinet, the space of the flue gas flow;2. heat exchange tube, the water vapor flow area. Due to the flue gas flow part involves only flow, it use the unstructured hexahedron mesh, the hexahedralelements [3]. For the quality of the water vapor flow, it use the structured hexahedron mesh, as the high requirements for computation of heat transfer and flow. Boundary conditions are set in table 2.

TABLE 2. SUPERHEATER BOUNDARY CONDITIONS OF THE MODEL

| name | value | name | value |
|----------------------------|--------|----------------------------|--------|
| Imported steam temperature | 600.3k | inlet flue gas temperature | 1300k |
| steam exit temperature | 628.7k | outlet gas temperature | 1000k |
| vapor velocity | 5m/s | velocity of flue gas | 0.5m/s |

III. THE NUMERICAL MODEL

Superheater of heat transfer to flue gas and water vapour in the heat exchange tube coupling the two independent computing area. Heat transfer of superheate is the calculation area coupling between the water vapor in flue gas and heat exchange tube.The two kinds of working medium heat through the wall. It Follows the mass conservation, momentum conservation and energy conservation. Expressed in mathematical formula is as follows:continuity equation :

$$\frac{\partial \rho}{\partial t} + \frac{\partial \rho u_i}{\partial x_i} = 0 \quad (1)$$

Momentum equation:

$$\frac{\partial(\rho u_i)}{\partial t} + \frac{\partial}{\partial x_j}(\rho u_j u_i) = \frac{\partial}{\partial x_j}[\mu \frac{\partial u_i}{\partial x_j} - \overline{\rho u'_j u'_i}] - \frac{\partial p}{\partial x_i} + \rho g_i \quad (2)$$

energy

equation:

$$\frac{\partial(\rho c_p \bar{T})}{\partial t} + \frac{\partial}{\partial x_j}(\rho c_p \bar{u}_j \bar{T}) = \frac{\partial}{\partial x_j} \left[\lambda \frac{\partial \bar{T}}{\partial x_j} - \rho c_p \bar{u}_j \bar{T} \right] + S_f + S_s \quad (3)$$

At the same time, the superheater the casing of the flow of the water vapor in the flue gas and the heat exchange tube belong to turbulent flow. This paper will use kappa epsilon - predominate model for both sides. In k - epsilon model, k equation and epsilon equations as follows:

$$\frac{\partial}{\partial t}(\rho k) + \frac{\partial}{\partial x_j}(\rho k u_j) = \frac{\partial}{\partial x_j} \left[\left(\mu + \frac{\mu_t}{\sigma_k} \right) \frac{\partial k}{\partial x_j} \right] + G_k + G_p - \rho \epsilon - Y_{M2} + S_k \quad (4)$$

$$\frac{\partial}{\partial t}(\rho \epsilon) + \frac{\partial}{\partial x_j}(\rho \epsilon u_j) = \frac{\partial}{\partial x_j} \left[\left(\mu + \frac{\mu_t}{\sigma_\epsilon} \right) \frac{\partial \epsilon}{\partial x_j} \right] + C_{\epsilon 1} \frac{\epsilon}{k} (G_k + C_{\epsilon 2} G_p) - C_{\epsilon 2} \rho \frac{\epsilon^2}{k} + S_\epsilon \quad (5)$$

The coupling using SIMPLE algorithm, speed and pressure with explicit discretization format control equation.

IV. RESULTS AND ANALYSIS OF THE MODEL

In the process of simulation, in order to more accurate analysis and comparison of validation, the simulation experiment set the parameters according to the literature [1] is set with the parameters [4]. The analysis of the simulation results can be divided into three parts , that the performance between the steam turbine and the boiler flue and parameters of the r inner steam. Simulation results will be the present thermodynamic calculation results of [1], the accuracy of the results of simulation.

the result of the flue gas side validation and analysis

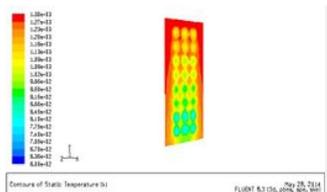


Figure 2 The flue temperature distribution in the cloud (x=750)

Figure 2 The flue temperature distribution in the cloud (x=750).Upper entry into the flue gas from the shell, the contact tube with heat transfer, heat transfer effect with the increase of heat exchange tube row number and gradually strengthened. Tube box near the change of the high low temperature in the middle on both sides, this is because in the first row and the third row tube bundle with most there is a certain distance between the outside of the body, so as to form the smoke corridor. Near the flue gas mass flow rate is higher, the average heat exchange area of flue gas relative to bundle area is lesser, so in less heat. But for flue center, because of its high resistance, flue gas heat exchange area is larger, the heat transfer is more, so the temperature is lower [5]. This makes the temperature distribution in the flue. Each branch pipe section outward from the center of the temperature distribution is not uniform.

Through simulation, it is concluded that the average temperature of flue gas is 837.65 K. By literature [1] average thermodynamic calculation of flue gas temperature is 837.80 K, the difference is not less than 0.2 K, is obtained by these two kinds of calculation of the average temperature of flue gas pipeline between perfectly.

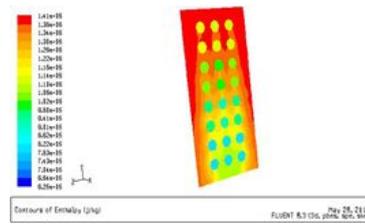


Figure 3 the flue enthalpy value distribution (x=750)

Above the picture, the color change and the temperature is almost the same. According to the formula can be seen $dH = C * dT$ enthalpy value is changing with the temperature, enthalpy change with the temperature change, so the enthalpy change also represents the change in temperature. Enthalpy value reflects the basic heat transfer conditions and temperature.

The results of the analysis and validation steam side

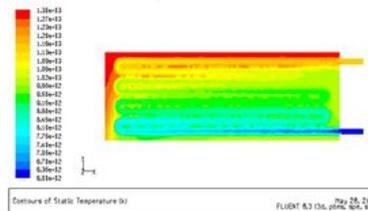


Figure4 Z=0 the temperature profile

As can be seen from the figure 4, steam flow temperature gradually become bigger, to enhance the heat transfer effect, has reached to the purpose of the heating boiler water. Pipe between the color change is a bit fuzzy, this is because the tube spacing is small, and result in heat transfer is not clear.

From the temperature distribution of water vapor flow from the bottom up, while the flue gas from the top down scour, two kinds of reverse flow way of heat transfer, fluid can have very good heat exchange effect. Implemented to reduce flue gas temperature, heat recovery of flue gas, enhance the utilization ratio of heat [6].

Using numerical simulation method to calculate the average exit temperature of the steam is 608.5, is obtained by thermodynamic calculation of steam temperature is 605 K, both differ 3.5 K.

tube steam parameters

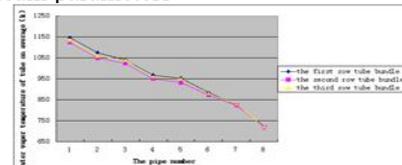


Figure 5 tube steam average temperature

As can be seen from the line chart from 1 to 8 in the temperature of the heat pipe is gradually reduced. Steam inlet temperature is low, on the flue gas from flushing pipe, steam and flue gas to heat, so the temperature rise gradually, the highest temperature after one pipe. When steam inlet temperature setting is 600.3 k, the number one pipe that is water vapor exit temperature can reach 1100 k, the heat exchange tube may cause overtemperature tube, the disadvantage for heat transfer, affect the normal work of the superheater. Through simulation calculation, the average temperature of water vapor inside 945.2 K, and the literature [1] of the steam pipe of average temperature of 947.1 K, 1.9 K, from both within reasonable error [7].

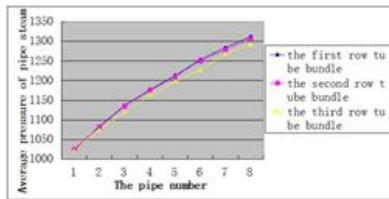


Figure 6 Average pressure steam pipe

From the figure 6 we can see that the pressure from inlet to outlet pipe in the smaller, the entire process showed a trend of the gradient. Water vapor inlet is higher than the outlet pressure, differential pressure, so that we can guarantee the working medium flow is relatively stable. Average pressure pipe steam through the numerical simulation of 1195.12 Pa and literature [1] the average pressure steam in the Pa 1198.13 3.01 Pa, with in the reasonable range of error.

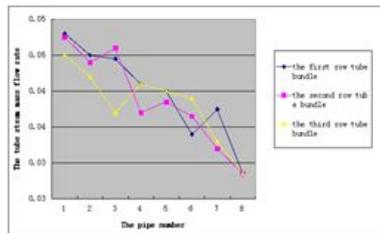


Figure 7. The tube steam mass flow rate

It can be seen from the figure 7 in a continuous flow, because the design of the partition, box made from no. 1, traffic to reduce with the increase of the number, the same as the design of far away from the diaphragm, starting from the pipe number 4, flow increases gradually along with the increase of the number [8]. At the same time, in general, bundle mass flow rate in each row are not many, the pipe, the smaller the number, namely the nearer the flue gas inlet, the heat load, the greater the flow become bigger. Recently, 1 from flue gas pipe, heat load is high, the steam temperature is high, more dangerous, local tube can occur, it should be noted.

V. THE CONCLUSION

This article through to in the power plant boiler superheater upstream modeling, and using the FLUENT software to the flue gas and tube wall and pipe steam simulation calculation, the analysis of simulation results can be divided into three parts, steam side respectively, and the flue gas side, as well as the inner steam parameters. It reached the conclusion.

From the simulation results, the analysis shows that the flue gas with the flow direction, the temperature gradually decreased; But because the body structure,

make the flue gas along the width direction, rendering the middle low two head high. Each branch pipe leads to uneven distribution of circular cross section.

From the steam side of the simulation results, analysis shows that water vapor flow from the bottom up, the flue gas from the top down scour, two kinds of reverse flow way of heat transfer, fluid raise the temperature of water vapor, flue gas temperature drop, implemented to reduce the flue gas temperature, heat recovery of flue gas, enhance the utilization ratio of heat.

From all the parameters of steam, chart analysis, the tube water vapor average temperature gradually increases with flow direction; At the same time average pressure appear smaller gradually trend of tube, this ensures that the flow of working medium, in line with the actual situation. Due to the design of partition of the starting number 1, traffic to reduce with the increase of the number, the same as the design of far away from the diaphragm, starting from the pipe number 4, flow increases gradually along with the increase of the number.

In this paper, the results of numerical simulation to calculate the average exit temperature of the steam is 608.5, is obtained by thermodynamic calculation of steam temperature is 605 K, both differ 3.5 K; Average temperature of the flue gas, steam average exit temperature, the average temperature of the water vapor and thermodynamic calculation results are basically in agreement with petitions, verified the accuracy of the experiment.

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Partial Discharge Comprehensive Fault Decision Of 0.4kv/10kv Power Transformer Based On Psd-Pso Algorithm

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Abstract—In order to insure the stability of power grid , 0.4kV/10kV power transformer PD on-line monitoring system is studied in this paper, With the help of pulse current method detection method, the PD propagation characteristics can be precisely located by the power spectrum density(PSD) .In order to have a good weight distribution of PSO and the statistical analysis problem , PSD-PSO algorithm is introduced in this paper. And the comprehensive fault decision based on PSD- PSO algorithm is studied in this paper. At last the simulation results show that the proposed method can improve the accuracy and the real time performance of fault diagnosis in power transformer.

Index Terms— Partial Discharge, Power Spectrum Density(PSD) , Particle Swarm Optimization (PSO), Comprehensive Fault Decision , 0.4KV/10KV Power Transformer.

I. INTRODUCTION

As an important part of transmission and distribution equipment, power transformers play important roles in power grid. Moreover, the overall deterioration of insulation level on power transformers is an important reference index for stable running and economic operation of power system .In view of the present situation that the periodical inspection and repair cycle cannot make the inspection and repair scientifically and reasonably, the insulation level of power transformers can not keep stable during the long term online operation. In order to insure the stability of power grid, it is indispensable to be reinforced the monitor and diagnosis of the transformer insulation. Partial discharge (PD) inside insulation is considered as one major cause of insulation degradation in transformer and attached importance to the safety and reliability of running transformer. Many researchers pay much more attention to the study of fault diagnosis of power transformers[1-4].

With the fast development of sensing technology, computer technology and information processing technology ,modeling analyzing and knowledge reasoning based on Rough set and ANN network have been studied in reference[5-7].esp. comprehensive application of internal fault diagnosis technology of transformer has been applied in industrial field[8-10].ANN network ,expert system and fuzzy set theory etc. play a promoting role in condition monitoring and fault diagnosis power grid equipments. In order to deal with weight distribution of PSO and the statistical analysis problem , the comprehensive fault decision based on PSD-PSO algorithm is studied in this paper. According to the problems existed in field 0.4kV/10kV power transformer PD on-line monitoring system, this paper researches the PD propagation characteristics based on the detection method of pulse current method(PCM).

II. PD TEST AND PROPAGATION CHARACTERISTICS DETECTION METHODS

Auto-recognition to discharge types in on-line PD monitoring system could be used to find out internal partial defects and the relevant discharge development degree in time, and then prevents equipment from the coming faults. In general, electromagnetic radiation, high frequency pulse, dielectric loss voice ,lighting and heating emitting can be monitored with the profile of PD in power equipments. And there are several PD propagation characteristics method discussed in the references[11-17].Electric methods and non-electric methods are to diagnose and correct problem situations for large power transformer. Such as pulse current method(PCM), dielectric loss method (DLM) and electromagnetic radiation method(ERM) have been studied in the past decade. According the IEC standards, PCM is the recommended detection method on PD propagation characteristics.

A.PD models and experimental devices

According to the internal insulation PD in the transformer and the PD propagation characteristics, there are three PD models are designed in this paper, which are shown in FIGURE.1. That is point discharge in transformer oil (P1) Solid Insulation of Power Transformer (P2), and surface discharge in transformer oil (P3) . The PD signals are measured by PCM. Test PD detection schematic diagram and experimental devices are shown in FIGURE.2 and FIGURE.3.

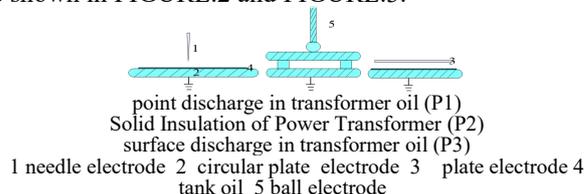


FIGURE. 1 PD models of artificial defects

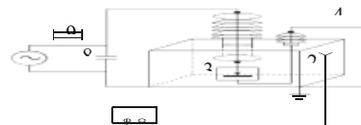


FIGURE.2 Test PD detection schematic diagram



FIGURE 3 Experimental devices on 0.4kV/10kV power transformer PD detection

B. Experimental procedure and starting discharge voltage VS. extinction voltage mode

In order to have a good contrast effect, starting discharge voltage VS. extinction voltage mode are studied in this experiment. With the study of point discharge in transformer oil the source voltage is gradually increased from 3.0 to 5.8 kV by 0.2kV step and the .PD distance is gradually increased from 0.5cm to 3.5cm On the other hand, with the study of surface discharge in transformer oil, the source voltage is gradually increased from 6.3 to 7.3 kV by 0.2kV step and the .PD distance is gradually increased from 1.5cm to 3.5cm. The experimental data(starting discharge voltage VS. extinction voltage) is shown in TABLE I and TABLE II. Furthermore, with the study of solid insulation of power transformer, the source voltage is gradually increased from 4.4 to 7.8 kV by 0.2kV step and the .PD distance is gradually increased from 1.5cm to 3.5cm. The experimental data(starting discharge voltage VS. extinction voltage) is shown in TABLE III

TABLE 1 PD DATA ON POINT DISCHARGE IN TRANSFORMER OIL (P1)

| distance /cm | Starting voltage /kV | Extinction voltage /kV |
|--------------|----------------------|------------------------|
| 3.5 | 5.8 | 5.0 |
| 2.4 | 5.0 | 4.6 |
| 1.0 | 4.5 | 4.1 |
| 0.5 | 3.0 | 2.4 |

TABLE 2 PD DATA ON SURFACE DISCHARGE IN TRANSFORMER OIL(P3)

| distance /cm | Starting voltage /kV | Extinction voltage /kV |
|--------------|----------------------|------------------------|
| 3.5 | 7.3 | 6.7 |
| 2.5 | 6.8 | 6.2 |
| 1.5 | 6.3 | 5.7 |

TABLE 3 PD DATA ON SOLID INSULATION OF POWER TRANSFORMER(P2)

| distance /cm | Starting voltage /kV | Extinction voltage /kV |
|--------------|----------------------|------------------------|
| 3.5 | 7.8 | 7.4 |
| 2.5 | 6.3 | 5.8 |
| 1.5 | 4.4 | 3.9 |

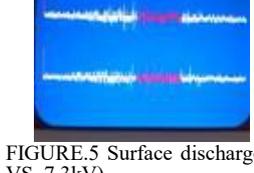
And the PD pulse map are shown in FIGURE.4.(point discharge)and FIGURE.5(surface discharge).As can be seen from the pulse map ,the initial pulse are at the point of 90°and 270°.With the increasing of source voltage, the number of PD pulses are increased and the PD pulse span are enlarged.



FIGURE.4 Point discharge PD pulse map under the voltage (3.0kV VS. 5.8kV)



FIGURE.5 Surface discharge PD pulse map under the voltage (6.3kV VS. 7.3kV)



Compared with FIGURE.4 and FIGURE.5 ,there are some difference between point discharge PD pulse map and surface discharge PD pulse map at the viewpoint of statistical analysis. In order to have a good weight distribution of PSO ,the power spectrum density(PSD) are introduced in this paper.

C. Power Spectrum Density Analysis

PSD analysis is the method which indicate the relation between the power change and the frequency variation. The most part of the PSD is the calculation of spectral density function. With the help of PAD analysis, statistical operator, pulse waveform characteristics, and fractal characteristics in 2 dimensions or 3 dimensions can be considered. As can be shown in equation 1, the frequency of PD and the maximum PD value can be calculated by the different windows spectral density functions (such as Boxcar data sampling, Hamming data sampling and Blackman data sampling etc.).

$$\int_{-\infty}^{+\infty} |s(t)|^2 dt = \int_{-\infty}^{+\infty} |S(f)|^2 df \tag{1}$$

III. PARTIAL DISCHARGE PATTERN RECOGNITION

A. Data Preprocessing

With the help of PD monitor (JFD251) and 50 times PD experiments on 0.4kV/10kV power transformers, there are three types PD models Δ Q-U mode data can be obtained. As a PD data sample $x_i = [x_1, x_2, x_3, \dots, x_k]^T$, where k is the sampling numbers in the unity time. In this paper , source voltage (in P1)is gradually increased from 3.0 to 5.8 kV by 0.2kV each step, so the $k_1=(5.8-2.0)/0.2=19$.

In the same way , k_2 (in P2)= $(7.8-4.4)/0.2=17$, and k_3 (in P3)= $(7.3-6.3)/0.2=5$.since the difference among the parameters k_1, k_2 and k_3 , normalization processing is very essential in PD data preprocessing. As is shown in equation 2, 120samples can be obtained in the experiments with the three modes (P1,P2 and P3).

$$x(t)_{un} = \frac{\max\{x(i)\} - x(t)}{\max\{x(i)\} - \min\{x(i)\}} \tag{2}$$

In order to have a good pattern recognition result, based on 10-fold cross-validation are proposed. Moreover there are 60 classification samples and 40 test samples. In this way ,we can get a samples matrix $X_{un}(120*60)$.

B. Pattern Discovery Flow Chart

In order to have a good and fast pattern recognition result on the classification between P1,P2 and P3. There are two testing parts in the PD pattern recognition: data-training stage and data-testing stage. The flow chart based on PSD-PSO algorithm is shown in FIGURE.6.

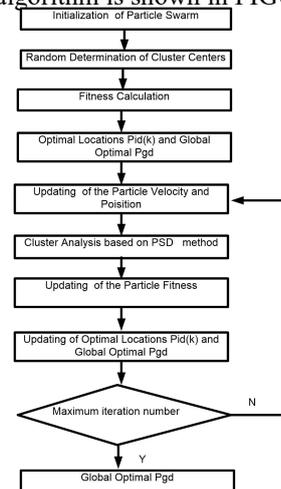


FIGURE.6 Flow Chart based on PSD-PSO Algorithm

C. Pattern Analysis

In order to get fast and accurate pattern recognition results, the 3-D colourful PD images are converted to the 2-D gray PD images, as can be show in FIGURE.7. With help of PSD method ,the power spectrums of different PD propagation characteristics can be obtained in FIGURE. 8.

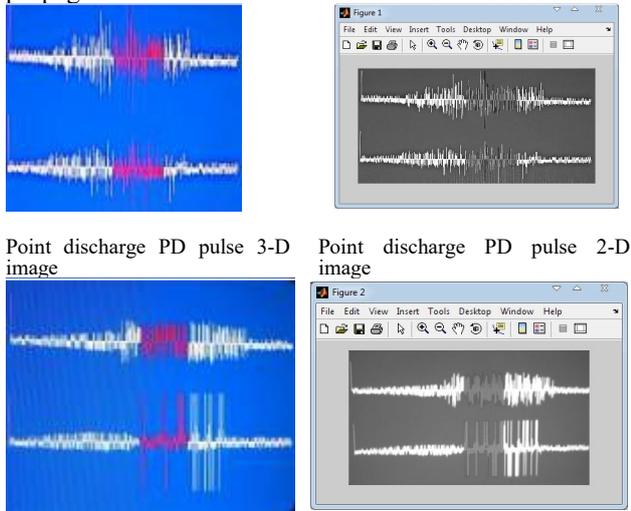


FIGURE. 7 Gray-conversion on PD Images

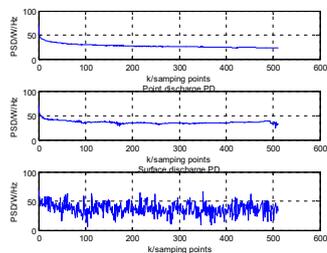


FIGURE. 8 Power Spectrums of Different PD Propagation Characteristics

D. Identification Results

With help of Matlab 7.0, the PD propagation characteristics identification results and PD pattern samples (3 types P1, P2 and P3, 512 data in one type.) are displayed in TABLE 4. And pattern recognition results by BP algorithm with the same computer (with CPU of Celeron 400 MHz) are also shown in TABLE 5.

TABLE 4 RESULTS OF PATTERN RECOGNITION BY PSD-PSO ALGORITHM

| PD types | Results of pattern recognition | | | Tims/ms | correct rate |
|----------|--------------------------------|-----|-----|---------|--------------|
| | P1 | P2 | P3 | | |
| P1 | 490 | 10 | 12 | 35 | 95.7% |
| P2 | 8 | 503 | 1 | 45 | 98.2% |
| P3 | 5 | 10 | 495 | 37 | 96.7% |
| Average | | | | 39 | 96.9% |

TABLE 5 RESULTS OF PATTERN RECOGNITION BY BP ALGORITHM

| PD types | Results of pattern recognition | | | Tims/ms | correct rate |
|----------|--------------------------------|-----|-----|---------|--------------|
| | P1 | P2 | P3 | | |
| P1 | 438 | 25 | 49 | 203 | 85.5% |
| P2 | 33 | 427 | 52 | 173 | 83.4% |
| P3 | 23 | 50 | 439 | 190 | 85.7% |
| Average | | | | 188.7 | 84.9% |

As can be seen from TABLE 4 and TABLE 5, compared with the BP ANN network ,PSD-PSO algorithm can improve the accuracy(from 84.9% to 96.9%) and the real time performance (39ms VS. 188.7 ms) of fault diagnosis in power transformer.

CONCLUSIONS

In this paper, partial discharge comprehensive fault decision of 0.4KV/10KV power transformer based on PSD-PSO algorithm is discussed. The simulation results show that the improved PSD-PSO algorithm has the advantages of better classification effect (from 84.9% to 96.9%), being easy to realize and better real time performance (39ms VS. 188.7 ms) of fault diagnosis in power transformer.. And the simulation results also demonstrate the effectiveness of the improved method .On the other hand, the PSD-PSO method can meet the requirements of comprehensive fault decision on other power equipments such as power switchgears and porcelain insulators etc.

ACKNOWLEDGMENTS

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Partial Discharge Fault Decision And Location Of 24kv Multi-Layer Porcelain Insulator Based On Power Spectrum Density Algorithm

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Abstract -In order to insure the stability of power grid , 24kV multi-layer porcelain insulator PD monitoring system is studied in this paper, With the help of pulse current method detection method, the PD propagation characteristics can be precisely located by the power spectrum density(PSD) .In order to have a good comparison, the PD experiments on 24kV multi-layer porcelain insulator are in the implementation under drying conditions . And the comprehensive fault decision based on PSD algorithm is studied in this paper. With the different layer PD faults, the causes and faults can be easily located by PSD algorithm is introduced in this paper. At last the simulation results show that the proposed method can improve the accuracy and the real time performance of fault diagnosis in 24kV multi-layer porcelain insulators.

Key words: Partial Discharge, Power Spectrum Density(PSD) , Fault Decision and Location, Comprehensive Fault Decision , 24kV multi-layer porcelain insulators, Pulse Current Method(PCM)

I.INTRODUCTION

According to power system statistics report, more than 37% blackouts on power distribution system is caused by insulation failure[1].Insulation fault in multi-layer porcelain insulators is a potential threat to flight safety of the 24kV power grid stable operation[2-4]. There is no doubt that multi-layer porcelain insulators play important roles in power transmission. Auto-recognition to discharge types in on-line PD monitoring system could be used to find out internal partial defects and the relevant discharge development degree in time, and then prevents equipment from the coming faults. In general, electromagnetic radiation, high frequency pulse, dielectric loss voice ,lighting and heating emitting can be monitored with the profile of PD in power equipments. And there are several PD propagation characteristics method discussed in the references [5-7]. Electric methods and non-electric methods are to diagnose and correct problem situations for large power transformer. Such as pulse current method(PCM), dielectric loss method (DLM) and electromagnetic radiation method(ERM) have been studied in the past decade. According the IEC standards, PCM is the recommended detection method on PD propagation characteristics.

A.PD models and experimental devices

According to the internal insulation PD in porcelain insulators and the PD propagation

characteristics, there are three PD models are designed in this paper, which are shown in Fig.1. That is point discharge in transformer oil (P1) Solid Insulation of Power Transformer (P2) , and surface discharge in transformer oil (P3) . The PD signals are measured by PCM. Test PD detection schematic diagram and experimental devices are shown in Fig.1 and Fig.2.

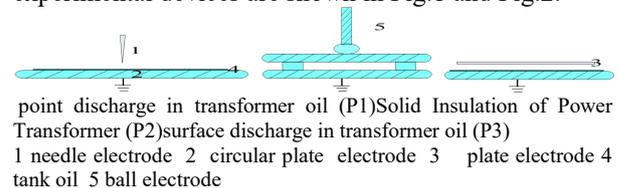
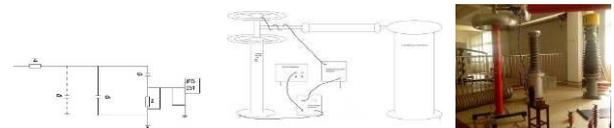


FIGURE. 1PD models of artificial defects



a Electric Schematic Diagram b Physical Connected Circuit c Actual Connection

FIGURE. 2 Detection Circuit on PD of 24kV Multi-layer Porcelain Insulators

TABLE 1 STARTING DISCHARGE VOLTAGE VS. EXTINCTION VOLTAGE UNDER THE DRYING CONDITION.

| LAYER NUMBER | STARTING VOLTAGE /KV | UMAX/K V | EXTINCTION VOLTAGE /KV |
|--------------|----------------------|----------|------------------------|
| 7 | 52 | 57.9 | 48 |
| 6 | 38.8 | 44 | 32.7 |
| 5 | 34.1 | 38.9 | 28.3 |
| 4 | 28.1 | 32.4 | 22 |
| 3 | 24.2 | 28.4 | 15.6 |
| 2 | 18.7 | 22.6 | 10.1 |
| 1 | 14.5 | 19.3 | 8.1 |

B. Power Spectrum Density Analysis

PSD analysis is the method which indicate the relation between the power change and the frequency variation. The most part of the PSD is the calculation of spectral density function. With the help of PAD analysis, statistical operator, pulse waveform characteristics, and fractal characteristics in 2 dimensions or 3 dimensions can be considered. As can be shown in equation 1, the frequency of PD and the maximum PD value can be calculated by the different windows spectral density functions (such as Boxcar data sampling, Hamming data sampling and Blackman data sampling etc.).

$$\int_{-\infty}^{+\infty} |s(t)|^2 dt = \int_{-\infty}^{+\infty} |S(f)|^2 df \tag{1}$$

II. EXPERIMENTAL PROCEDURE

A. PD Experimental Requirements

In order to have a good contrast effect, starting discharge voltage VS. extinction voltage mode are studied in this experiment. With the study of surface discharge in 24kV multi-layer porcelain insulators the source voltage is gradually increased by 1kV,2kV and 3kV separately . When the surface of 24kV multi-layer porcelain insulators are under the drying condition, the surface discharge experiments are implemented with different layers form 1 to 7. Moreover the starting discharge voltage VS. extinction voltage mode are shown in table 1.

With the study of surface discharge in 24kV 7-layer porcelain insulators the source voltage is gradually increased from 52 to 57.8 kV by 0.48kV step. In this way ,we can get 12 PRPD patterns(from t=0.1to 1.2s,with time interval of 0.1s) in fig. 3 .In order to have a quick and accurate calculation on power spectrum density, the 3-D colourful 12 PRPD patterns are converted to the 2-D grey PD images, as can be show in fig. 4. With the help of Matlab 7.0 , the 24kV Multi-layer Porcelain Insulators PSD values in different PRPD grey-patterns of PD can be obtained, which are shown in fig. 5.

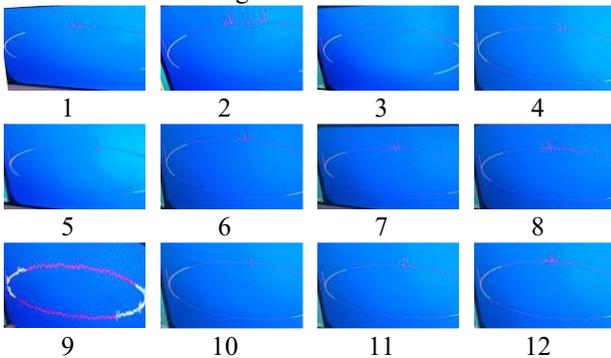


FIGURE.3 24kV MULTI-LAYER PORCELAIN INSULATORS PRPD PATTERNS OF PD (FROM LEFT TO RIGHT AND FROM UP TO BOTTOM, THE 0.1S TO 1.2S PRPD PATTERNS UNDER DRYING CONDITION AND LAYER NUMBER =7, THE SAME TO FIG.4 AND FIG.5)

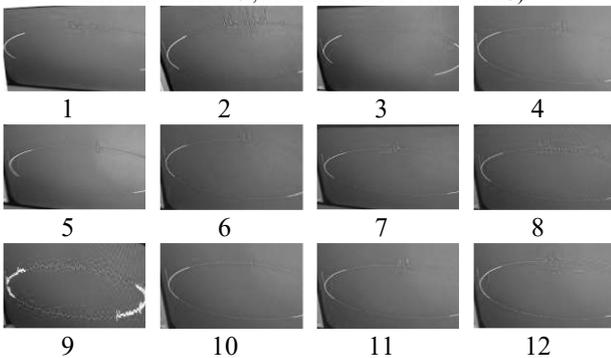


FIGURE.4 24kV MULTI-LAYER PORCELAIN INSULATORS PRPD GREY-PATTERNS OF PD

With consideration of random disturbance and statistical characteristics in different PRPD grey-

patterns of PD, the experimental results should be considered in one cycle. Furthermore , the PRPD grey-patterns of PD are also varied with different electromagnetic environments. Compared with Fig.3 and Fig.4 ,we know that the big fluctuation on PRPD patterns may be not the characteristic value for different operation conditions.

B. PD Data's-analysis with PSD Method

In this way ,some classification methods should be considered, such as SVM, fuzzy clustering method and some ANN methods. In this paper , PSD method are proposed in PD data's-analysis.

With help of MATLAB 7.0 and PSD tool, the PRPD grey-patterns of PD are converted in Fig.5. As can be seen from the fig. 5, the PSD mean value and variance value of 24kV 7-layer Porcelain Insulators are shown in Table 2. When the variance value is more large , the PSD mean value is more fluctuant .And the results have more typical resolution on patterns of PD, except the special changes on the first data and the fourth data (which shown with yellow colour background) .

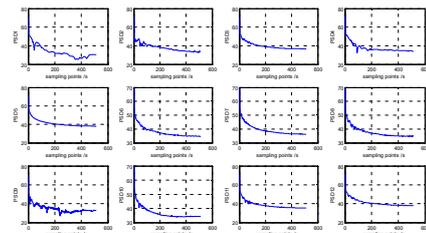


FIGURE..5 24kV MULTI-LAYER PORCELAIN INSULATORS PSD VALUES IN DIFFERENT PRPD GREY-PATTERNS OF PD

TABLE 2 PSD MEAN VALUE AND VARIANCE VALUE OF 24kV 7-LAYER PORCELAIN INSULATORS

| MEAN VALUE/ VARIANCE VALUE | | | |
|----------------------------|------------|------------|------------|
| K1:33.31 | K2:37.8148 | K3:39.7116 | K4:37.4712 |
| 63/41.732 | /17.1364 | /15.717 | /21.3663 |
| K5:41.16 | K6:37.8365 | K7:39.3415 | K8:37.7466 |
| 62/16.244 | /16.1358 | /16.0575 | /16.3457 |
| K9:34.65 | K10:36.893 | K11:38.448 | K12:41.073 |
| 11/18.3673 | 9/18.6764 | 5/15.6617 | 2/15.6617 |

As can be concluded the Table 2 and according to equation 2,the mean PRPD grey-pattern value can be obtained .(M stands for typical value of PSD)

$$M = \frac{1}{9}(k2 + k3 + k5 + k6 + k7 + k8 + k9 + k10 + k11 + 12) \tag{2}$$

(where K1 and K4 is singular value for the calculation of PSD values).

Then the PSD values- Δ U hysteretic curve of 7 and 6 layers porcelain insulators PRPD patterns can be shown in Fig.6.

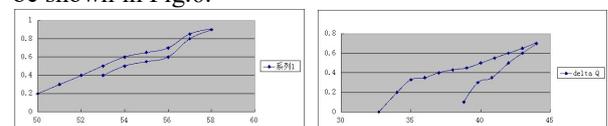


FIGURE.6 PSD VALUES-ΔU HYSTERETIC CURVE OF 7 LAYER AND 6 LAYER PORCELAIN INSULATORS PRPD PATTERNS(ΔQ:Y-AXIS ,U :X-AXIS)

As can be seen from the Fig.6, PSD values- ΔU hysteretic curve of different layer porcelain insulators PRPD patterns have different PSD values. in this way

we can locate the position and the value of PD faults. The data details are show in table 3.

TABLE 3 PSD VALUES- ΔU HYSTERETIC CURVE OF DIFFERENT LAYERS PORCELAIN INSULATORS PRPD PATTERNS

| 7LAYER VOLTAGE Q | DELTA | 6LAYER VOLTAGE Q | DELTA | 5LAYER VOLTAGE Q | DELTA | 4LAYER VOLTAGE Q | DELTA | 3LAYER VOLTAGE Q | DELTA | 2LAYER VOLTAGE | DELTA Q | 1LAYER VOLTAGE | DELTA Q |
|------------------|-------|------------------|-------|------------------|-------|------------------|-------|------------------|-------|----------------|---------|----------------|---------|
| 52 | 0.1 | 38.8 | 0.1 | 34.1 | 0.1 | 28.1 | 0.1 | 24.2 | 0.1 | 18.7 | 0.1 | 14.5 | 0.1 |
| 53 | 0.4 | 39.8 | 0.3 | 35 | 0.25 | 29 | 0.4 | 25 | 0.2 | 20 | 0.2 | 16 | 0.15 |
| 54 | 0.5 | 40.8 | 0.35 | 36 | 0.4 | 30 | 0.45 | 26 | 0.4 | 21 | 0.25 | 17 | 0.2 |
| 55 | 0.55 | 42 | 0.5 | 37 | 0.5 | 31 | 0.48 | 27 | 0.55 | 22 | 0.35 | 18 | 0.3 |
| 56 | 0.6 | 43 | 0.6 | 38 | 0.55 | 32.4 | 0.6 | 28.2 | 0.57 | 22.6 | 0.45 | 19.3 | 0.4 |
| 57 | 0.8 | 44 | 0.7 | 38.9 | 0.65 | 31 | 0.55 | 27 | 0.55 | 22 | 0.4 | 18 | 0.37 |
| 58 | 0.9 | 43 | 0.65 | 38 | 0.6 | 30 | 0.5 | 26 | 0.48 | 21 | 0.38 | 17 | 0.35 |
| 57 | 0.85 | 42 | 0.6 | 37 | 0.55 | 29 | 0.48 | 25 | 0.45 | 20 | 0.36 | 16 | 0.3 |
| 56 | 0.7 | 41 | 0.55 | 36 | 0.5 | 28 | 0.45 | 24 | 0.33 | 19 | 0.32 | 15 | 0.28 |
| 55 | 0.65 | 40 | 0.5 | 35 | 0.45 | 27 | 0.42 | 23 | 0.28 | 18 | 0.3 | 14 | 0.25 |
| 54 | 0.6 | 39 | 0.45 | 34 | 0.4 | 26 | 0.38 | 22 | 0.25 | 17 | 0.28 | 13 | 0.22 |
| 53 | 0.5 | 38 | 0.43 | 33 | 0.3 | 25 | 0.35 | 21 | 0.22 | 16 | 0.25 | 12 | 0.2 |
| 52 | 0.4 | 37 | 0.4 | 32 | 0.29 | 24 | 0.3 | 20 | 0.2 | 15 | 0.24 | 11 | 0.15 |
| 51 | 0.3 | 36 | 0.35 | 31 | 0.28 | 23 | 0.2 | 19 | 0.18 | 14 | 0.2 | 10 | 0.15 |
| 50 | 0.2 | 35 | 0.33 | 30 | 0.25 | 22 | 0 | 18 | 0.15 | 13 | 0.18 | 9 | 0.1 |
| 49 | 0.1 | 34 | 0.2 | 29 | 0.2 | | | 17 | 0.1 | 12 | 0.17 | 8.1 | 0 |
| 48 | 0 | 32.7 | 0 | 28.3 | 0 | | | 15.6 | 0 | 10.1 | 0 | | |

III. CONCLUSIONS

In this paper, the comprehensive fault decision based on PSD algorithm is studied. Furthermore, the PD experiments on 24kV multi-layer porcelain insulator are in the implementation under drying conditions and the PSD values are obtained by image recognition. With the help of Matlab 7, the simulation results show that the proposed method can improve the accuracy and the real time performance of fault diagnosis in 24kV multi-layer porcelain insulators.

ACKNOWLEDGEMENT

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The Development of Green Economy in China— —Basic Findings in Recent Years

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Abstract—The purpose of this essay is to describe and discuss the development of practice and theories in China. In this essay, certain conditions that show China has the ability to cope after the Global reform on green economy are given. In addition, the significance on developing multilateral green economic is given in this essay.

Index Terms—green economy, China, development, basic findings

I. PROCESS OF DEVELOPMENT

Green economy is based on the market as the guidance, on the basis of the traditional industrial economy, for the purpose of the harmony of economy and environment and to develop a kind of new economic form. It is a state of development from the industry economy, in order to meet the need of human health and environmental protection and produce and shows.

2014 GGEI PERCEPTION SURVEY RESPONDENTS

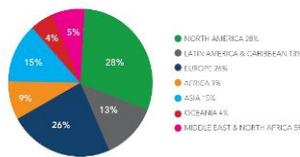


FIGURE 1. 2014 GGEI PERCEPTION SURVEY RESPONDENTS

The green economy is a kind of economy which takes resource-conserving and environment-friendly economy as the main content; while producing low resources consumption, little environmental pollution and high value-added products. It is a new form of economic mode of intensive production. Green economy has the feature of owning comprehensive strength, wide coverage and drive effect significantly. It can form and drive a large number of emerging industries, to help create jobs and expand domestic demand, to promote the economy out of crisis mud and to achieve economic important support of steady growth. From the data (figure1-1) below, we can see that the whole world is beginning to focus on the topic of the development of the green economy. While at the same time, the green economy has the important feature of resource saving and environment friendly. It takes green economy and green industry as the connotation, including a low-carbon economy, circular economy and ecological economy, high technology industry, is beneficial to promote the economy in our country, which favors high-energy consumption, high material consumptions, high pollution, and high emissions of extensive development mode. Developing the green economy can help promote

the intensive economic development and sustainable growth of China.

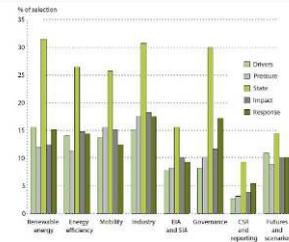


Figure2. DPSIR analysis of priority areas (green economy)

II. REALIZE THE PATH OF ECONOMIC GROWTH

Using more renewable energy, green economy always performs well at supporting the development of green technology, reducing carbon dioxide emissions, and green economy can create more jobs that are decent, reduce the critical resources such as oil import dependence. Its development can help Chinese people build the country into a place with more forest area, more perfect municipal solid waste management, more and more public transportation, green buildings, and healthier way of consumption and less wasted food.

Practice the path of green economic development will certainly have some impact on China's GDP. Nevertheless, the effect is still manageable. In the green scenario, GDP growth might slow down, but it can still maintain a certain growth. From the perspective of the GDP of three scenarios, brown scene still has certain advantages. In the Green scene(Figure 1-3), from 2015 to 2020, GDP growth will fell from 7.46% to 7.28% of the baseline scenario. From 2020 to 2030, it may drop from 4.75% to 4.52%; while from 2030 to 2050, it may drop from 2.73% to 2.42%. Moreover, although growth is falling, but the growth rate is still acceptable.



FIGURE 3. GLOBAL GREEN ECONOMY INDEX

Green scene is conducive to safeguard China's economic growth into a more healthy status. Most of the studies show that the international crude oil prices impact on China's economy has negative effect (Wang

Weiwei, Qui Lisheng, 2011). Under the background of Green scenario, China's oil demand is reducing, and its dependence on imports is declining, which can reduce the impact of oil price changes on economic growth. Under the background of Green scene, from 2011 to 2050, China's oil demand reduction can achieve 181 million tons per year on average.

Continue on a more green development path, the peak of China's carbon dioxide emissions will achieve in advance. Under the green scenario, China's carbon dioxide emissions will peak in 2025, by 9.702 billion tons. Under the brown scenario, China's carbon dioxide emissions is still growing, by 2050 will reach 2050 tons of standard coal (figure 1-3). Keep on the path of developing green economy in China both from the perspective of practice and theories would make huge contribution to global carbon dioxide emissions.

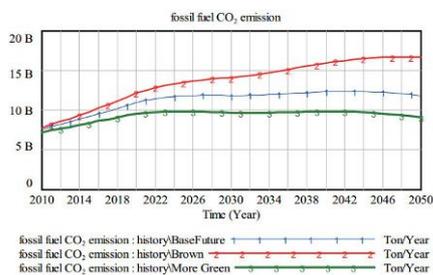


FIGURE 4 FOSSIL SUEL CO2 EMISSION

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An Overview of Car Electric Power Steering System Algorithm

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Abstract—The development history and research status of electric power steering system in China and abroad are summarized in this article. The working principle, structure and characteristics of electric power steering system are introduced. The performance of electric power steering and the main problems in the present are analyzed. Finally, the development trend of electric power steering system is prospected. Research shows that the electric power steering has a very important position in the future with its obvious advantages and development potential.

Index Terms—Car, electric power steering, algorithm, performance, development

I. INTRODUCTION

Electric power assisted steering (EPS/EPAS) or motor driven power steering (MDPS) uses an electric motor to assist the driver of a vehicle. Sensors detect the position and torque of the steering column, and a computer module applies assistive torque via the motor, which connects to either the steering gear or steering column. This allows varying amounts of assistance to be applied depending on driving conditions. Engineers can therefore tailor steering-gear response to variable-rate and variable-damping suspension systems, optimizing ride, handling, and steering for each vehicle [1]. On Fiat group cars the amount of assistance can be regulated using a button named “CITY” that switches between two different assist curves, while most other EPS systems have variable assist. These give more assistance as the vehicle slows down, and less at faster speeds.

A mechanical linkage between the steering wheel and the steering gear is retained in EPAS. In the event of component failure or power failure that causes a failure to provide assistance, the mechanical linkage serves as a back-up. When EPAS fails, the driver encounters a situation where heavy effort is required to steer. This heavy effort is similar to that of an inoperative hydraulic steering assist system [2]. Depending on the driving situation, driving skill and strength of the driver, steering assist loss may or may not lead to a crash. The difficulty of steering with inoperative power steering is compounded by the choice of steering ratios in assisted steering gears vs. fully manual. NHTSA has assisted car manufacturers, such as Ford, with recalling EPAS systems prone to failure.

Electric systems have an advantage in fuel efficiency because there is no belt-driven hydraulic pump constantly running, whether assistance is required or not, and this is a major reason for their introduction. Another major advantage is the elimination of a belt driven engine accessory, and several high pressure hydraulic hoses between the hydraulic pump, mounted on the engine, and the steering gear, mounted on the chassis. This greatly simplifies manufacturing and maintenance [3]. By incorporating electronic stability control electric power steering systems can instantly vary torque assist levels to aid the driver in corrective maneuvers.

The first electric power steering system appeared on the Suzuki Cervo in 1988. Today a number of manufacturers use electric power steering [4].

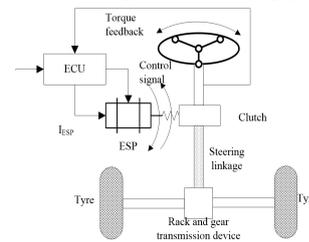


Figure 1. ESP system diagram.

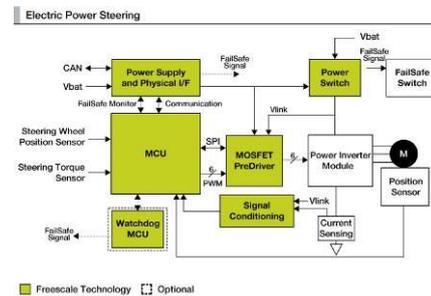


Figure 2. Electric power steering.

II. HISTORY OF THE ESP

The first power steering system on an automobile was apparently installed in 1876 by a man with the surname of Fitts, but little else is known about him. The next power steering system was put on a Columbia 5-ton truck in 1903.

Robert E. Twyford, a resident of Pittsburgh, Pennsylvania, included a mechanical power steering mechanism as part of his patent (U.S. Patent 646,477) issued on April 3, 1900 for the first four wheel drive system [5].

Francis W. Davis, an engineer of the truck division of Pierce-Arrow, began exploring how steering could be made easier, and in 1926 invented and demonstrated the first practical power steering system. Davis moved to General Motors and refined the hydraulic-assisted power steering system, but the automaker calculated it would be too expensive to produce [6]. Davis then signed up with Bendix, a parts manufacturer for automakers. Military needs during World War II for easier steering on heavy vehicles boosted the need for power assistance on armored cars and tank-recovery vehicles for the British and American armies.

Chrysler Corporation introduced the first commercially available passenger car power steering system on the 1951 Chrysler Imperial under the name “Hydra guide”. The Chrysler system was based on some of Davis's expired patents. General Motors introduced the 1952 Cadillac with a power steering system using the work

Davis had done for the company almost twenty years earlier [7].

Charles F. Hammond, an American, born in Detroit, filed several patents for improvements of power steering with the Canadian Intellectual Property Office in 1958.

Most new vehicles now have power steering, owing to the trends toward front wheel drive, greater vehicle mass, and wider tires, which all increase the required steering effort [8]. Heavier vehicles, as are common in some countries, would be extremely difficult to maneuver at low speeds, while vehicles of lighter weight may not need power assisted steering at all.

III. STATUS QUO OF EPS

To provide steering assistance, an electric motor mounted to the side of the rack housing drives a ball-screw mechanism via a toothed rubber belt. The screw engages a spiral cut in the outside of the steering rack. A torque sensor attached to the pinion shaft signals a control computer when to provide assistance.

Pinion Shaft Steering Torque Sensor Rack-and-Pinion Housing Electric Motor

Ball-screw Mechanism Steering Rack Drive Belt

Makers are moving aggressively to EPS because eliminating an engine driven hydraulic pump increases gas mileage by about 1 mpg. Before hydraulic power steering (HPS) goes the way of the buggy whip, though, we wanted to understand the differences so we concocted this test [9]. BMW conveniently offers both types of assist on 5-series models equipped with four-wheel drive. (HPS survives here because the slightly bulkier EPS unit fits in only the four-cylinder model.) A \$61,125 BMW 528i xDrive served as our EPS lab rat while its 535i xDrive (\$69,695) sibling stood up for HPS. Beyond the type of steering assistance, the notable differences are six cylinders in the 535i xDrive versus four in the 528i xDrive, 143 pounds more weight on the more expensive BMW's front axle, and 19 inch 40 series tires (535i) versus 18-inch 45-series rubber on the 528i. The basic run-flat, all-season tire design and 245-mm -section width are common to both.

We divided our test into two segments a hands-on, purely subjective driving evaluation, followed by instrumented proving-grounds tests. For the first phase, a steering committee of 11 editors with many decades of combined experience drove the BMWs without knowing what type of steering assist was at work over our favorite southeast Michigan test loop: 13.8 miles of whoops and hollows, sweeping lefts, and decreasing radius rights; essentially our own North American Nordschleife [10]. Each driver completed one 10-item ballot per car. Then the two BMWs were handed over to colleagues at Cayman Dynamics, where engineers fit an array of sensors and recorded for analysis the results of various steering response tests.

Several of our findings were predictable; some surprised us. The first discovery was that neither BMW excels in steering feel and feedback, an observation consistent with the mediocre reviews we've given every 5-series, including the M5, since the sixth-generation design arrived three years ago.

After griping about EPS for years, the shocking revelation is that C/D's editorial staff preferred BMW's electric system over its hydraulic assistance. Total votes in seven out of ten rating categories favored EPS by two to eight points each [11,12]. Hydraulic shined in only the three Feedback categories where it won the on-center comparison by four points and tied with EPS in our middle of maneuver and at cornering extremes performance ratings [13].

IV. PROSPECT OF EPS

In 2000, Honda launched the S2000 Type V equipped with the world's first electric power variable gear ratio steering (VGS) system. In 2002, Toyota introduced their own "Variable Gear Ratio Steering (VGRS)" system introduced on the Lexus LX 470 and Land cruiser Cygnus, and also incorporated the electronic stability control system to alter steering gear ratios and steering assist levels [14]. In 2003, BMW introduced their "Active Steering" system on the 5-series. Mercedes calls its system Direct-Steer.

This system should not be confused with variable assist power steering, which varies steering assist torque, not steering ratios, or with systems where the gear ratio is only varied as a function of steering angle. These last are more accurately called non-linear types; a plot of steering-wheel position versus axle steering angle is progressively curved (and symmetrical).

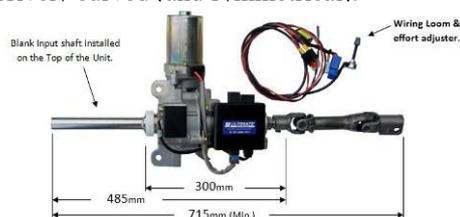


Figure 3. Latest EPS system.

Electric Power Assisted Steering systems will displace traditional hydraulic power steering systems over the next decade. Globe Motors has assisted in the development of these systems since the inception of EPAS. As a result, we have become a trusted and valuable partner to Tier 1 suppliers of these systems [15].

Using a Globe Motors DC brushless motor in the EPAS system ensures the reliability needed to allow the EPAS system to deliver superior performance, fuel economy, and safety, while reducing overall costs and assembly time.

Our DC brushless motors enhance EPAS system response. They do the heavy work when steering at low speeds and incorporate the sensor feedback instantaneously to maintain the traditional feel of responsiveness at high speeds.

EPAS systems improve fuel economy and reduce emissions by allowing the automobile's engine to operate more efficiently and by reducing the weight of the vehicle. Traditional belt and pulley driven systems continually drain power from the engine, reducing its operating efficiency and increasing emissions. The Globe Motors DC brushless motor operates independently of the engine. This can increase fuel economy by more than five percent. Motor-driven steering systems are also much lighter, often less than half the weight of traditional power steering systems.

Because the Globe Motors DC brushless motor operates independently of the engine, it provides steering assistance, even when the engine is not running. This increases driver and passenger safety.

V. CONCLUSION

Electronic and control technology is mature, so that EPS develops rapidly in recent years. At present, EPS has been used in many kinds of light car, which has a wide range of 1.3L-1.6L, and its performance has been widely recognized. With the further improvement of environmental protection, energy saving and safety requirements, EPS represents the development direction of modern automobile steering system because of its

series of advantages. EPS will dominate the market in the power steering system, and the application will become more and more extensive.

ACKNOWLEDGMENT

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Fault Diagnosis Research of Intelligent Technology and Its Application

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Abstract—Faults of large-scale and complex mechanical equipments are characterised by complexity uncertainty syndrome. If a single intelligent technique is utilized to diagnose these faults, it would be too difficult to obtain a satisfied diagnosis result. Generally, the diagnosis accuracy of the single intelligent technique is lower and generalization ability is weaker. Thus, it is urgent and necessary to present a novel idea and method to solve these practical engineering problems.

Index Terms—mechanical device, fault diagnosis, intelligent diagnosis

I. INTRODUCTION

Although domestic and foreign research and application of hybrid intelligent fault diagnosis has made encouraging progress, but in terms of the device itself and applied to the field of hybrid intelligent fault diagnosis technology, there are still the following problems:

① current diagnostic methods and intelligent diagnostic system, mostly alone use some smart technology, such as based on fuzzy reasoning, neural networks, or two single smart technology in the sense of simply "stacking", failed to consider a variety of intelligent methods between organic ties and mutual integration, so there is no full play to their respective advantages in the diagnosis.

② various intelligent diagnostic methods of the present study, usually a signal processing and feature extraction methods: for example: wavelet analysis, empirical mode decomposition, higher-order spectrum, time-frequency analysis or time domain, frequency domain statistical analysis to extract features. Single feature extraction method, there is no full use of multi-feature domain fault information, resulting in incomplete diagnostic information; simultaneously without taking into account the different characteristics of the fault diagnostic sensitivity is suppressed to improve diagnostic accuracy, weakening the intelligent classifier robustness and reliability[1].

③ most of the current hybrid intelligent fault diagnosis method just stay in the experimental simulation stage, and early diagnosis instance, weak and very few concurrent multiple faults. According to the actual needs of the project, research hybrid intelligent diagnosis early, weak and multiple fault diagnosis, and the development of practical engineering fault diagnosis system is urgently needed to solve the problem.

④ hybrid intelligent diagnostic technology research has just started, or traditional use feature extraction methods and intelligent diagnostic technology. In order to obtain a satisfactory diagnosis requires the use of advanced signal processing technology and smart technology. So propose a new method of signal processing and improve existing smart technology, and applied hybrid intelligent diagnosis system is another issue hybrid intelligent diagnostic technology to solve.

⑤ existing hybrid intelligent diagnostic systems are mostly used for off-line diagnostics, leading to advanced theory, information technology and data can not be shared, resulting in a waste of knowledge resources.

Therefore, the development of hybrid intelligent fault diagnosis system based on a network, so that the hybrid intelligent diagnostic technology, "Internet", saving diagnostic resources, reduce the cost of diagnosis is the actual needs of the project, but also the urgent need to address the problem.

A. Fuzzy set theory

In the engineering field, fuzziness everywhere. Operating status of the device to determine, from the "safe" state to the "unsafe" there is a transition zone between the state, the two states that border is blurred. Description of the mechanical state of the system, such as noise, vibration serious, large axial deformation, are fuzziness concept. With the rapid development of modern science and technology, the increasing complexity of various devices, fuzzy set theory provides a powerful mathematical tool for large and complex fault diagnosis equipment. According to Zadeh fuzzy mathematics founder's "exclusion principle", when the complexity of the system increases, the ability to accurately and effectively describe the behavior of the system is reduced, when it reaches a certain threshold, the accuracy and validity (or related resistance) becomes mutually exclusive. Therefore, the higher the complexity of the equipment, the ambiguity of its system is also stronger[2]. Using the basic principles of fuzzy mathematics, fuzzy information processing equipment condition monitoring and fault diagnosis encountered in the analysis, fault diagnosis of complex equipment will open up new and effective ways.

University of California at Berkeley Zadeh LA in 1965 on "information control" journal published a seminal paper on fuzzy set theory(Fuzzy Set Theory, FST)'s. First proposed the concept of expressing important things fuzziness-membership functions. Establish the concept of breaking the limitations of 19th century German mathematician Cantor G. founded the classical set theory. Membership functions can be expressed by means of a fuzzy concept from "not belong" to the excessive "fully belong", it can all be quantified fuzzy concept. Proposed basis of membership functions of fuzzy theory. The common elements of the collection of membership collection can only take two values, 0 and 1, this can be extended to take any value interval [0, 1], which can be used to quantitatively describe the elements of membership in line with the concept of domain theory degree. Practice has proved that the fuzzy set theory in image recognition, atmospheric forecasting, earthquake geology, transportation, medical diagnostics, information control, artificial intelligence, and many other areas have also been noticed. From the development trend of the discipline of view, it has an extremely strong vitality and penetration[3].

B. Genetic Algorithms

Genetic Algorithm (Genetic Algorithm, GA) originated in a computer simulation study of biological systems conducted. Holland Michigan University professor and his students inspired by biological simulation technology to create an adaptive probability based on genetic and evolutionary biological mechanisms for complex system optimization optimization techniques

- genetic algorithms. From the entire development process of genetic algorithms, the 1970s is the rise phase, the 1980s was the development stage, the 1990s was the climax stage. Genetic algorithms as a practical, efficient and robust optimization techniques, extremely rapid development, has caused scholars are highly valued.

Genetic algorithms are a class of stochastic search algorithm, which can effectively use some of the information processing has to search for those who are looking to improve the quality of solution strings. Similar to the natural evolution, genetic algorithm by acting on the gene on a chromosome, chromosome looking good to solve problems. Similar nature, genetic algorithms to solve the problem itself ignorant treatment, it needs only generated for each chromosome algorithms were evaluated, and based on the fitness value to change the chromosome, the chromosome makes the difference between good adaptability than the adaptability chromosomes have more breeding opportunities.

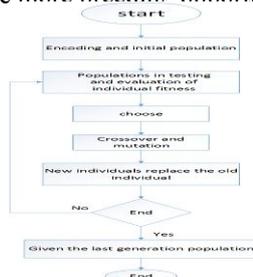


Figure1. genetic algorithm flowchart

Genetic algorithms simulate the occurrence of natural selection and genetics and other reproduction, crossover and mutation phenomenon, starting from an initial population through selection, crossover and mutation, resulting in a group of individuals better adapted to the environment, so that group evolved into the search space more good area, from generation to generation reproduction evolved, and finally converge to the optimal solution best adapted to individual environmental group, obtained the problem. It's the basic process shown in Figure 1. First, the feasible domain encoded. Then, in a group of randomly selected feasible region coding (chromosomes, individual) as a starting point for the evolution of the first generation of groups and individuals is calculated for each coding values applicable, and fitness embodies the objective function optimization information. Then, as with nature, randomly selected from the population as a number of individual sample collection before the breeding process, selection mechanism should ensure a high degree of individual adaptation to retain more of the sample, while the fitness of individuals will be kept low with less sample or eliminated. During the breeding process, the use of two kinds of crossover and mutation operators, to a certain crossover and mutation rate on the exchange after the selection of the sample to give a new individual. Finally, replace the population by the next generation of new and old individuals. Algorithm repeats the above evaluation, selection crossover and mutation process until the end condition is satisfied[4]. Typically, the last generation of the evolutionary process to adapt to the highest population of individuals is the final result of the use of genetic algorithm to solve optimization problems.

II. MODERN SIGNAL PROCESSING TECHNIQUE

Three steps in fault diagnosis, fault diagnosis is the key feature extraction, the traditional signal analysis techniques can not effectively extract feature information early, weak and composite failure. For large and complex diagnostic equipment, you need to use modern signal processing methods to extract fault feature. In this paper, the use of two novel non-stationary signal analysis techniques - wavelet analysis and empirical mode decomposition, the following will introduce these two modern signal analysis techniques.

A. wavelet transform and wavelet packet analysis

Wavelet analysis is the Fourier transform, Gabor analysis, a direct result of the development of short-time Fourier transform, which is a Fourier transform when established on the basis of frequency analysis method, has the characteristics of multi-resolution analysis is very suitable for analysis of non-stationary signals. When it is, the frequency domain signal also has the ability to characterize local features, and has a good effect in fault detection and diagnosis of dynamic systems. But it is a time for the low-frequency portion of the signal is decomposed gradually to the low-frequency range focus, high-frequency part of the reservation does not move, so the frequency resolution of the high-frequency portion of the poor[5]. Wavelet packet transform is the development and extension of the wavelet transform, which is the time-frequency localization properties inherited wavelet transform, wavelet transform is no longer continue to break down the high frequency band is further decomposed, full-band multi-level signal band division, the signal mapping to these bands, the signal in weak signal characteristics emerge, providing a more precise description of the means of the signal.

B. wavelet function Features

(1) wavelet function in the time domain has a compact support (function domain finite non-zero) or similar compact support. In principle, any satisfy conditions allow (R) of the space can be used as mother wavelet function (including real or complex functions, compactly supported non-compact support function, regular or non-regular functions, etc.). However, under normal circumstances, is often chosen compactly supported or similar compact support (with a time-domain locality) have regular sex (with frequency domain locality) real or complex functions as a mother wavelet function to make the mother wavelet in the frequency domain has a better local properties.

(2) Since the mother wavelet function satisfies the conditions allow, that the DC component is zero, that is, the wavelet will have alternating positive and negative volatility.

When given below short Fouereir transform and wavelet transform frequency window features:

C. Wavelet Packet Algorithm

The basic principle known by the wavelet transform, wavelet transform on the phase plane, with the reduced scale j, the time-domain window width corresponding wavelet function decreases its frequency-domain window width increases. That is, the frequency-domain window function with the corresponding wavelet scale decreases. In general, small scale signal contains many high frequency components, corresponding to wide-band; while large-scale signal, usually contain only low frequency components corresponding to the narrow band. This small-scale wavelet transform large frequency windows, large-scale frequency when a small window of time-frequency distribution of the same nature in the signal frequency characteristics consistent [6]. Thus, with small to large-scale changes, wavelet analysis arbitrary scale suitable for signal conversion. In fact, the wavelet transform in which time-frequency distribution is very useful in many cases, but this time in some situations the fixed frequency distribution of the wavelet transform of the window is not an optimal choice. In fact, in many of the problems in some people just interested in a specific time segment or the frequency band of the signal, as long as the extraction of the specific time, and frequency information has been. Therefore, in the hope that the natural period of interest on the time resolution of the maximum possible increase in the frequency band of interest most likely to increase the frequency resolution. The wavelet transform provides frequency phase plane will not meet this requirement.

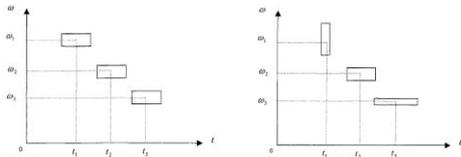


Figure2. Frequency characteristics window when converting short Fourier
Figure3. the frequency window characteristics of wavelet transform

III. HYBRID INTELLIGENT TECHNOLOGY IN REMOTE DIAGNOSIS SYSTEM

Fault diagnosis is a very practical subject, the ultimate goal of their research is effective diagnostic techniques and methods used in equipment condition monitoring and fault diagnosis, the science and technology into productivity, the carrier of these techniques and methods are monitoring and diagnosis system, its research and development is increasingly important. Therefore, pay attention to the theoretical innovation, more attention should be paid has developed some practical fault diagnosis system. According to expert analysis, the theoretical level of diagnostic technology has reached or close to international standards, but in the popularization and application, with the international advanced level is far greater for the production and application service gap. The reason is mainly theoretical and applied research site was not well combined. In recent years, the Chinese government has given high priority, "Ninth Five" climbing program, "fifteen" technological breakthroughs, 863 high-tech Research and Development Program, the National Natural Science Fund projects will also be developed fault monitoring and diagnosis system as a key content .

Equipment monitoring layer using the measured point detection feature of the front end of the data provided in real-time monitoring and control equipment to complete the process of running and together with complete equipment and the corresponding controller scheduling and optimization. its logical structure shown in Figure 4:

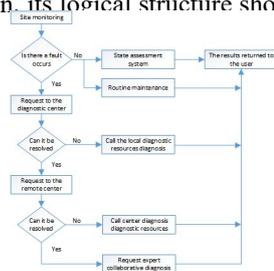


Figure4. Remote Intelligent Fault Diagnosis System work flow chart

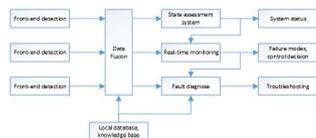


Figure5. logical structure equipment monitoring layer

In Figure 5, the status of the underlying device and process information detected by the front-end acquisition and processing, the formation of characteristic data into the monitoring system data fusion module, forming a centralized signal. Since the signal is present focus is inconsistent, redundant and conflicting issues such as the use of a standardized data fusion process of state-specific data into the system status assessment, real-time status monitoring and fault diagnosis of the three parallel processing module. State assessment system as a reference to the ideal state to complete the identification system is abnormal status and future trends[7]. When an exception occurs, the real-time detection module based

on the failure modes during operation characteristics affect the classification and come running fault on the manufacturing process, the formation of the corresponding control strategies available to the controller, and eliminate the influence of scheduling. The status monitoring and scheduling closely linked, is the core of the monitoring system.

IV. CONCLUSION

In recent years, due to the development of computer technology, signal processing, artificial intelligence, pattern recognition technology, and promote the continuous development of fault diagnosis technology. Especially intelligent fault diagnosis method has been widely studied. Intelligent Fault Diagnosis currently focused on the following aspects:

(1) the introduction of some new theoretical troubleshooting process, such as information fusion fault diagnosis, fault diagnosis based on evolutionary algorithms, Agent-based fault diagnosis, model-based reasoning graph theory, fault diagnosis method based on nuclear, etc., along with continuous development of new theories, work in this area is still an important part of fault diagnosis.

(2) diagnostic systems integration, several diagnostic methods will be integrated into the integrated fault diagnosis together to achieve integration of various diagnostic methods. Such as the wavelet transform, fuzzy mathematics, neural network integrated fault diagnosis method together. Because each method has its advantages and disadvantages, this integrated fault diagnosis method must have its own unique advantages. This is also one of the elements to be studied in depth.

(3) diagnostic system integration, the past simply by monitoring and diagnosis, the next set of monitoring, testing, diagnosis, management, fo recasting and training in an integrated systematic direction.

(4) With the development of artificial intelligence, people are increasingly aware of the superiority of common sense and natural intelligence of the human operator, the fault diagnosis system appropriate to consider the role of people will reduce the failure rate of false positives and false negatives. Fault diagnosis is a very practical technology, only in practical applications in order to reflect its value. At present, although a lot of progress in the study of theory, but real engineering practice examples of successful application is also less, therefore, how advanced fault diagnosis theory and methods applied to the actual go remains to be further studied.

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