Design of Automatic Test System For Real-Time Sensitive Information of Large Electromechanical Communication Equipment

Wen Liu
School of Mechanics Institute, Wuhan Textile University, Wuhan, 430200, China

Abstract: The sensitive information test of communication equipment is of great significance to ensure the normal production of machinery. The traditional sensitive information test methods have defects in hardware, which lead to the problems of high delay and small amount of maximum information concurrency. In view of the above problems, an automatic test system for real-time sensitive information of large mechanical and electronic communication equipment is designed. Based on the traditional system, RF receiver nRF24L01 and TMS320 are designed to realize the function of communication information acquisition. On the basis of designing the improved hardware part of the system, design the software part of the system. Fourier transform and correlation analysis are carried out on the signals collected and processed by hardware to separate the non-discrete information sequence. Clustering algorithm is used to cluster the separated information sets, identify sensitive information, realize automatic test of real-time sensitive information, and complete the design of automatic test system for real-time sensitive information of large electromechanical communication equipment. By comparing with the traditional sensitive information testing system, it is proved that the designed automatic testing system has short delay, can bear more information concurrency and better performance.

Keywords: Large machinery; Electronic communication equipment; Real-Time sensitive information; Automated testing; System design

1. Introduction

Large machinery is the main tool in industrial production and manufacturing, which is of great significance to the development of related industries. Large mechanical structure is more complex, the use of a variety of electronic communication equipment to assist. However, the development of science and technology has brought hidden trouble to the communication security of electronic communication equipment. Criminals will obtain sensitive information in the communication information of large mechanical and electronic communication equipment through relevant technical means, and obtain benefits or disrupt the production and construction process through various ways such as selling, tampering and chaos, thus bringing huge economic losses to the machine users [1]. Therefore, it is necessary to use the sensitive information test system of electronic communication equipment with better performance to test the sensitive information of electronic communication equipment in real time.

The basic hardware performance of traditional sensitive information testing system is poor, which leads to the delay of information data transmission. Some use the principle of vector correlation degree to identify sensitive information with large errors, which eventually leads to poor test accuracy, long delay and poor test effect of the traditional real-time sensitive information test system for electronic communication equipment [2]. The application of automation test principle to design the test system can save the labor input to a certain extent without affecting the work of large machines. Based on the above analysis, this paper will design a real-time sensitive information automation test system for large electromechanical communication equipment. The following is the specific design content.

2. Hardware Design of Automatic Test System For Real-Time Sensitive Information of Large Mechanical and Electronic Communication Equipment

The main function of the hardware part of the automatic test system for real-time sensitive information of large electromechanical communication equipment designed in this paper is to collect the communication information between the electronic communication equipment and transmit the collected information to the software part of the system for subsequent processing. The transmission delay of hardware system is the physical basis of the whole automation test system. Therefore, the hardware part of this system is designed on the basis of the hardware part of the traditional real-time sensitive information automation test system.

In this paper, RF receiver nRF24L01 and TMS320 are used to collect the communication information. The RF receiver chip is controlled by TMS320 to collect the information of large mechatronic communication equipment. The following is a partial physical picture of the system hardware.

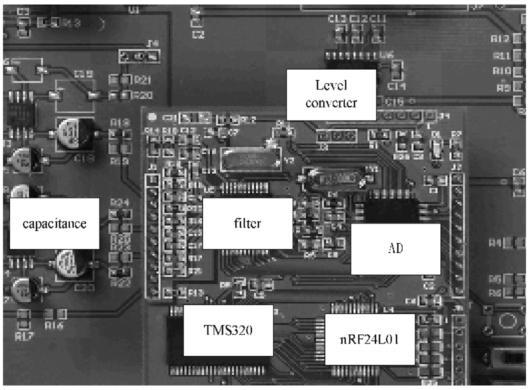

Figure 1. A partial physical drawing of the system hardware

The communication information between electronic communication devices is in the form of radio waves, the signal frequency is 2.5~3GHz, while the RF chip nRF24L01 operates at the frequency of 2.4~3.75GHz. When it is necessary to test the real-time communication information of large electromechanical communication equipment, the RF receiving chip will receive the communication information in the form of wireless, and carry out the signal modulation and demodulation, power amplification, filtering and other preliminary processing in the chip, the signal will be transmitted to the software part of the system through the communication bus for further processing. The TMS320 chip controls the working mode by controlling the three pin states of the RF chip nRF24L01. The operating mode of the RF chip corresponding to different pin states is shown in the following table [3].

Table 1. Working mode of RF chip nRF24L01

nRF24L01 working mode	PWR_UP	CE	CS
Receiving mode	1	1	0
Configuration mode	1	0	1
Standby mode	1	0	0
Shutdown mode	0	—	—

The RF chip transmits the received communication information to the TMS320 chip. The AD converter inside the TMS320 carries on the signal processing operation such as analog to digital conversion to the information signal. The DSP of TMS320 chip is connected with FLASH memory by the low 8-bit data bus of the chip to realize the reading of the system software program. When the automated test system is electrified or reset, the in-chip bootstrap program starts to query the status of the interrupt pin, thus controlling the program reading. DSP is connected with multiple rams, which can realize real-time acquisition of communication information of a large number of electronic communication devices at the same time [4].

After TMS320 further processes the collected communication information, the information is transmitted to the computer through PCI bus. PCI bus has a clock frequency of 33MHz, a width of 32 bits, and a bandwidth range of 124MB/s to 275MB/s. Moreover, when PCI and the computer carry out information data transmission, the clock frequency of the computer CPU will not affect the clock frequency of the PCI bus, so as to realize instantaneous transmission of a large amount of data, and improve the efficiency of the information automation test system [5]. The above is the hardware part of automation test system for real-time sensitive information of large-scale mechatronic communication equipment. Based on the designed hardware part of the system, the software part of the system is designed to achieve the expected function of the system.

3. Software Design of Automation Test System For Real-Time Sensitive Information of Large Electromechanical Communication Equipment

3.1. Electronic communication equipment information preprocessing

In order not to affect the real-time communication of large electromechanical communication equipment, the sensitive information automatic test system needs to preprocess the information data. Fourier transform is applied to the communication information of electronic communication equipment processed by hardware. If the length of the information sequence is N, the formula for the discrete Fourier transform of the information sequence in the time domain is as follows [6].

$$X(k)=\sum_{n=0}^{N-1} x(n) e^{\frac{-2pf}{kn}}, k=0,1,2,\mathbf{K},N-1 \qquad (1)$$

In formula (1), $x(n)$ is the information sequence of the electronic communication equipment in the time domain, f is the frequency of the communication signal, and n is the number of sampling points. After the Fourier transform of the signal in time domain, the correlation analysis method is used to separate the deterministic signal, that is, the non-sensitive information signal, from the transformed information sequence.

For the discrete information sequence in the time domain, the correlation calculation formula is as follows [7-8].

$$Rxy[i]=\sum_{k=0}^{m-1}x[k+n-1-i]y[k] \tag{2}$$

In formula (2), $i=0,1,2,\ldots,n+m-1$ .When $i<0$ or $i\geq n$, $x[i]=0$; When $i>0$ or $i\leq m$, $y[i]=0$. According to formula (2), the correlation value between the discrete information in the discrete information sequence is calculated, and the non-sensitive information in the communication information of the electronic communication equipment is separated according to the flow shown in the following figure.

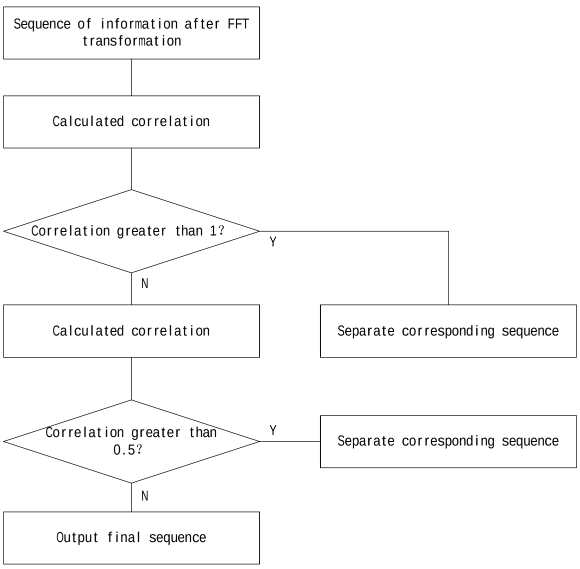

Figure 2. Separates non-sensitive information

The remaining information after being separated by correlation function is composed of information data set. Clustering method is used to identify sensitive information of information set and realize automatic test of real-time sensitive information of electronic communication equipment.

3.2. Sensitive information recognition test

In this paper, the method of clustering is used to identify the real-time sensitive information of large electromechanical communication equipment. The feature vector in the sample set is used as the cluster center of the clustering algorithm. The feature extraction algorithm is used to extract the feature of the separated information set. In order to reduce the dimension of information feature vector in information set, as few feature vectors as possible are used to represent the feature of information. The extracted feature vectors are mapped into the feature vector space and the Euclidean distance between the feature vectors and the elements in the feature sample set of sensitive information is calculated. The calculation formula of Euclidean distance is shown as follows [9].

$$dist\left(P_i,Q_j\right)=\sqrt{\sum_{i=1,\,j=1}^{n}\left(p_i-q_j\right)^2} \tag{3}$$

In formula (3), $dist\left(P_i,Q_j\right)$ is the Euclidean distance between the feature vector and the elements in the feature sample set of sensitive information, P_i is the feature sample set of sensitive information, Q_j is the information set to be recognized, p_i is the element in the feature sample set of sensitive information, and q_j is the information to be recognized. The smaller the value of $dist\left(P_i,Q_j\right)$ is, the more features of sensitive information are included in the information to be identified [10]. The clustering threshold is set according to the size of the sensitive information sample set, and the information to be recognized less than the threshold is clustered into the sensitive information cluster. The vectors in the sensitive information cluster are mapped back to the original space, and the corresponding sensitive information is output to complete the automatic test of real-time sensitive information of electronic communication equipment. The above is the software part of the automated test system designed. So far, the design of automatic test system for real-time sensitive information of large mechanical and electronic communication equipment has been completed.

4. Experiment

In this paper, an automatic test system for real-time sensitive information of large electromechanical communication equipment is designed. In order to test the performance of the system, the following experimental contents are designed.

4.1. Experiment content

In order to make the experimental conclusion scientific and effective, this experiment is a comparative experiment. The reference group of the experiment is the traditional automatic test system for sensitive information, and the experimental group is the automatic test system for real-time sensitive information of large electromechanical communication equipment designed in this paper. The experimental objects are 8 groups of large mechanical electronic communication equipment with two in a group. In order to ensure the authenticity and effectiveness of the experimental data, the parameters of the two electronic communication equipment in each group are exactly the same.

The comparison index of the experiment is the system delay between the experimental group and the reference group in the test process and the maximum amount of concurrent information that the system can bear on the premise of ensuring the test accuracy. Prepare the experimental equipment and complete the performance comparison of the two systems according to the experimental procedures.

4.2. Experiment preparation

The electronic communication equipment used in the experiment was numbered according to the group, and the communication information set was prepared, into which different amounts of sensitive information were added. The experimental communication information is divided into 8 groups and labeled. The software part of the system of the experimental group and the reference group runs on two calculations with identical configurations. The specific configuration of the computer is as follows:

4.2.1. Hardware environment

Computer CPU: Intel (R) Core (TM) i7-3975 @3.75GHz
Memory (RAM): 8GB
System type：64-bit operating system
Graphics card：GTX1600

4.2.2. Software environment

Operating system: Windows 8.1
Database: MySQL 5.5
Experimental data processing software: MATLAB 2012a
Before the experiment, the two systems in the experimental group and the reference group were respectively run to ensure that the two systems could operate normally and have complete functions. After preparation for the experiment, follow the following experimental steps.

4.3. Experimental steps

After the test system can run normally, the experimental electronic communication equipment communicates according to the set communication information set. Firstly, the delay of the system was tested. The systems in the experimental group and the reference group respectively tested the communication information between the electronic communication devices, and recorded the time difference between the two systems from the communication of the electronic communication devices to the test results of the system's output of sensitive information. This time difference is considered as the delay of the automated test system for sensitive information. Record the experimental data of system delay test, analyze and draw the corresponding experimental conclusion.
Secondly, under the premise of ensuring the accuracy of the test system, the two systems can bear the maximum amount of concurrency. With the improvement of the test accuracy required by the two test systems, the maximum amount of concurrency that the two systems can withstand is tested. Record the maximum concurrent data and compare the advantages and disadvantages of the two systems.

4.4. Experimental results

The delay comparison results of the automated test system of the experimental group and the reference group are shown in the following figure. The relationship between the curves in the figure is analyzed and the corresponding conclusion is drawn.

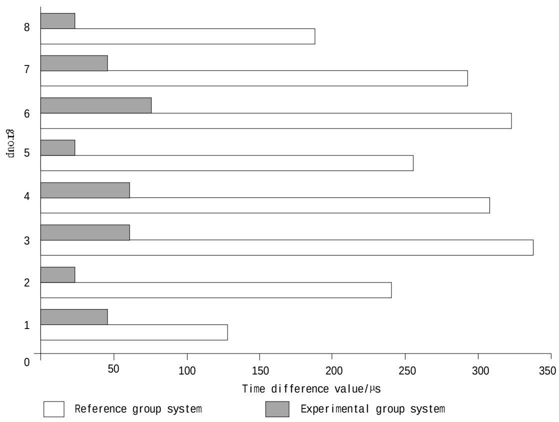

Figure 3. System delay comparison results

According to the above figure, when testing the real-time sensitive information of electronic communication equipment of different groups, the time difference between the test result output of the system of the experimental group and the start of communication is much smaller than that of the reference group, that is, the delay of the system of the experimental group is much smaller than that of the system of the reference group. It indicates that compared with the reference group system, the experimental group system can quickly output the sensitive information test results in a shorter time.
On the premise of ensuring the test accuracy of the automated test system in the experimental group and the reference group, the comparison results of the maximum concurrent amount of information data that can be carried by the two systems are shown in the following table.

Table 2. Comparison results of maximum concurrent load carried by the system

Test accuracy /%	Experimental group /dB	Reference group /dB
70	3472	2339
75	2911	2301
80	2883	2211
85	2736	1968
90	2585	1686
91	2321	1443
92	2221	1152

93	2099	1124
94	2012	992
95	1709	962

It can be seen from the above table that with the increasing of the test accuracy requirements of the automated test system, the maximum concurrency amount that the two systems can bear on the whole shows a certain downward trend. However, when the required test accuracy was between 70 and 85%, there was no significant change in the maximum amount of concurrency that the system of the experimental group could bear, while when the test accuracy of the reference group was close to 85%, there was a downward trend. When the required test accuracy of the system is greater than 85%, the maximum amount of concurrency that the reference group system can bear begins to decrease, and with the increase of the test accuracy, the rate of decrease of the amount of concurrency increases. Although the maximum amount of concurrency that the experimental system can bear is also decreasing, the rate of decrease is far less than that of the reference system. It shows that the experimental group system can test more sensitive information on the premise of ensuring test accuracy, that is, the experimental group system performance is more stable.

To sum up, compared with the traditional automatic test system for sensitive information, the automatic test system for real-time sensitive information of large mechanical and electronic communication equipment designed in this paper can reduce the system delay and carry more concurrent information, thus improving the performance.

5. Conclusion

Electronic communication equipment of the importance of sensitive information from test to guarantee communication security, aiming at the problems existing in the traditional sensitive information, this paper designed a large mechanical electronic communication equipment real-time sensitive information automation system, through the comparative experiments with traditional automated test system, proved in this paper, the design of the system's performance is superior.

References

[1] Hu Hongqi. Research on electronic communication information storage based on ordering optimized algorithms. Electronic Design Engineering. 2019, 27(19), 80-84.

[2] Sha Letian, Xiao Fu, Chen Wei, et al. Sensitive information leakage awareness method for big data platform based on multi-attributes decision-making and taint tracking. Journal on Communications. 2017, 38(07). 56-69.

[3] Yi Hua, Han Xiao, Wang Kailun, et al. Application of Internet of things technology to safety monitoring automation system of large hydropower station. Journal of Yangtze River Scientific Research Institute. 2019, 36(06), 166-170.

[4] Wang Li. Technology detection of 5g mimo wireless communication system. Communications Technology. 2019, 52(06), 1320-1325.

[5] Geng Shengrong. Intelligent electronic communication equipment real-time evaluation system for anti-jamming performance. Electronic Design Engineering. 2019, 27(10), 118-122.

[6] Wang Ding, Wang Caijin, Xu Ning, et al. Research on automatic test system of lineside electronic unit based on virtual instrument technology. Railway Standard Design. 2018, 62(08), 159-162.

[7] Fan Wenbo, Guan Shilei, Fu Jinwei, et al. Test bench design for distribution automation power flow calculation. Power System Protection and Control. 2018, 46(08), 117-123.

[8] Li Chenyang, Chen Yin, Fan Yun, et al. Design of automated detection tool for sensitive path of websites. Information Security and Technology. 2018, 9(01), 69-73.

[9] Xu Qijun, Cao Jian. Development of intelligent testing system for gear pump. Chinese Hydraulics & Pneumatics. 2018, (01), 116-120.

[10] Ding Qun. Mobile terminal software performance test simulation based on fragile feature orientation. Computer Simulation. 2019, 36(09), 185-188+250.