Statistical Analysis of Failure Causes of Medical Electronic Instruments Based on High Performance Processors

Xiao Ning, Zhong Jiahong

Gannan Medical University, Ganzhou, Jiangxi, 341000, China

Keywords: Medical Electronic Instruments, Cause of Failure, Analysis

Abstract: Medical Instruments Can Be Described as the Right-Hand Man of Doctors' Clinical Diagnosis. Various Types of Medical Failures Will Occur in the Use of Medical Instruments, Which Have Certain Restrictions on Clinical Diagnosis. Medical Electronic Instrument is a System. in Its Fault Diagnosis, It is Suitable to Use System Principles and Methods to Analyze the Interrelation between Various Elements in the System and between the System and the External Environment, to Put Forward Assumptions, and Then to Verify Whether the Assumptions Are True One by One, and to Push Forward Step by Step Until the Reason for the Failure is Found. in This Paper, High-Performance Processor Technology is Used to Make Statistical Analysis on the Causes of Medical Electronic Instrument Failures. It Provides an Important Reference for Extensive Failure Analysis Activities and Improving the Reliability Level of Electronic Measuring Instruments.

1. Introduction

There Are Many Kinds of Medical Electronic Instruments and Equipment, Ranging from Implantable Cardiac Pacemakers, Extracorporeal Cardiac Pacemakers, Cardiac Defibrillators, Cardiac Pacemakers, Etc. Used for Cardiac Therapy and First Aid Devices to Extracorporeal Shock Wave Lithotriptors, Patient Invasive Monitoring Systems, Intracranial Pressure Monitors, Invasive Cardiac Output Meters, Etc. [1]. Medical Instruments Have Become an Indispensable Component in Medical Diagnosis, Which Can Not Only Improve the Image of the Hospital, But Also Improve the Accuracy of Doctors' Clinical Diagnosis. Photoelectric Sensors Are Widely Used in Medical Devices Due to Their Advantages of Small Size and Long Service Life [2]. However, in the Use of Photoelectric Sensors, There Are Often Some Failures. Timely Detection of These Failures and Effective Maintenance Are Not Only Conducive to Improving the Design and Manufacture of Photoelectric Sensors, But Also Conducive to the Continuous Improvement of Medical Level. At Present, Most Health Centers in China Cannot Reach It. in Order to Adapt to the Maintenance of a Variety of Instruments and Equipment, on the Basis of Familiar with the Structure and Principle of Various Instruments, the General Rule of Their Maintenance Technology is Basically the Same as the Program Method for Finding Faults [3]. in Order to Adapt to the Maintenance Work of Modern Instruments and Equipment, Maintenance Technicians Should Be Familiar with the Structure and Principle of Various Medical Electronic Instruments and Equipment, Summarize and Master the General Rules of Maintenance Technology and the Procedures and Methods for Finding Faults.

2. Fault Analysis

Fault Analysis is the Key to Judge, Find and Determine the Cause of the Fault. the Failure is Nothing More Than the User, the Environment and the Instrument Itself. for a Faulty Instrument, When There Are Some Complex and Hidden Faults, It is a Very Difficult and Difficult Job for Beginners or Personnel with Certain Maintenance Experience [4]. the System is in a Certain Environment and is Connected with the External Environment for the Purpose of Completing Certain Functions. Obviously, Medical Electronic Instruments Have the Above-Mentioned Basic Characteristics of the System. Therefore, in the Process of Fault Diagnosis, It is Necessary to Make Full Use of These Basic Characteristics to Carry out Systematic Diagnosis of the Instrument. Because There Are Many Kinds of Instruments, Their Working Principles and Structural

  DOI: 10.25236/ISMHI.2019.126

Characteristics Are Different, So There Are Many Kinds of Machine Failures and Causes. in Addition, Even If the Same Instrument Has the Same Fault, There Can Be Different Causes [5]. in the Absence of Circuit Diagrams and Other Maintenance Data, It is Sometimes Difficult to Carry out Board Repair, Not to Mention Component-Level Repair. At This Time, It is Even More Important to Use the on-Circuit Static Test Comparison Method of Integrated Circuits. Therefore, Fault Finding and Judgment is a Highly Technical and Empirical Work with High Difficulty.

3. Several Common Faults of Medical Instruments

3.1 Faults Arising from Daily Use

Under special circumstances, medical equipment operators are not familiar with the operation procedures of the equipment, which will lead to the failure of the normal operation of the medical equipment, or the failure of the medical equipment operators to master the use of the medical equipment, resulting in errors in diagnosis and treatment results. In medical equipment, there are many kinds of photoelectric sensors instead of one [6]. In terms of working properties, it can be divided into qualitative analysis of position sensing and quantitative analysis of light energy, while in terms of physical structure, it can be divided into only receiving external light and both emitting and receiving light. The performance or mechanical structure of electronic components, as a result of slow change over the service life, causes the failure of the instrument to work normally, which is called inevitable failure, such as transistor and electron tube decay and aging, electrolytic capacitor value change, potentiometer and changeover switch wear, etc. The initial stage of investment or the replacement period of medical instrument operators. From this, we know that some hospitals do not implement the training of medical instruments properly, and the training system and training content are not perfect, resulting in the lack of accountability of medical instrument operators. The lack of employment, retention and training of maintenance personnel makes maintenance technicians in a relatively passive working state and it is difficult to give full play to their advantages.

3.2 Instrument Failure Caused by Circuit

Circuit failure is the main cause of medical instrument failure. Generally, circuit failure will lead to instrument control failure and medical instrument failure. A pathological tissue dehydrator is like a system, which is composed of various layers of systems, namely, a circuit system part and a mechanical system part. These two systems have their own independence and respective functions [7]. The storage and working environment of the instrument shall be in accordance with the requirements specified in its technical conditions, and the instrument shall not be operated in damp, over-high or under-low temperature places, so as to avoid deterioration and damage of electronic components. For example, some photoelectric sensors are not equipped with relevant diagnostic software, some diagnostic software must use passwords to run effectively, and some diagnostic software can only make the running results clear under the guidance of relevant data. Whether it is an open circuit fault or a short circuit fault, it is included in the category of circuit fault. Open circuit fault includes fuse blowing, line breaking, etc. Short circuit fault is caused by the interconnection of main control circuit power supply and ground wire. Not working properly. There are soft faults such as component damage or poor contact in the machine, which need repair to make the instrument return to normal. The influence of environmental factors on medical electronic instruments cannot be underestimated. The electronic parts of the instruments have fewer failures and are more reliable.

3.3 Software Program Failure and Mechanical Failure

With the continuous development of social economy and science and technology, software programs are widely used in medical instruments in our country. At the same time, software failures will also occur. For example, if the number of files managed is large, it will lead to poisoning between storage resources, leading to computer crash and unable to ensure the normal operation of

medical instruments. Whether the voltage is too high or too low, and whether the temperature, humidity and air cleanliness of the environment in which the instrument is located are within the scope specified in the technical indexes of the instrument. On the other hand, check the appearance of the instrument, including checking whether the grounding wire of the instrument is in good condition and whether the knobs are adjusted in proper positions. When the junction temperature of the transistor is high, its penetration current and current amplification factor further increase, resulting in the transistor thermal breakdown. In addition, high temperature will reduce the use power of the resistor, resulting in an open circuit of the resistor. Based on this, find out the cause of the fault. Starting from the whole machine, the cause of the fault should be found out as completely as possible, and no leakage should be sent out. Then, the fault should be eliminated one by one, and finally the location of the fault should be found. In order to avoid spending time, can't find the reason, make yourself in trouble [8]. Perhaps it is because the corresponding drive module that selects the scanning spatial resolution cannot work normally due to too much dust on the reflector. There are more and more such errors in photoelectric sensors, and its characteristic is that the more dust accumulates, the higher the error frequency of the sensor. The main reason for this is that the medical instrument has not been used for a long time, and the mechanical running parts are rusted, which causes the mechanical rotating parts to become stuck, or when the medical instrument is collided, the device is damaged.

4. High Performance Processor Improves Reliability of Medical Electronic Instrument System

4.1 The Reliability of Components is Improved

Today, although more and more different reconfigurable processors and reconfigurable multiprocessor systems are introduced, the old taxonomy is no longer sufficient because it cannot distinguish between reconfigurable and static processor systems. This requires a finer separation of reconfigurable types [9]. Therefore, it is necessary to establish a new classification for reconfigurable single/multiprocessor system on chip. These reconfigurable systems are not only different from each other in terms of single or multiple data streams and instruction streams, but also different in terms of the level of reconfiguration they support. This results in a new classification as shown in Figure 1.

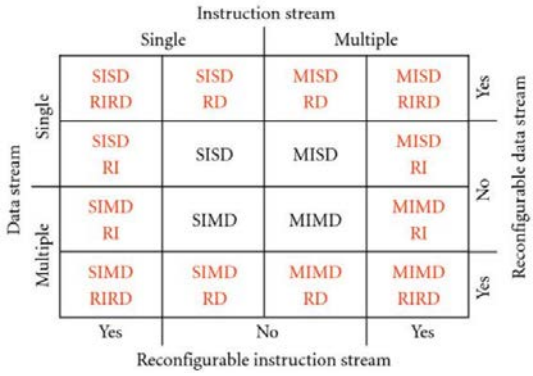

Fig.1 New Classification

Firstly, the system is divided into single instruction stream system and multiple instruction stream system. Secondly, they are further divided into single data stream system and multi-data stream system. In addition, these systems are separate in static and reconfigurable instruction stream systems. Reconfigurable instruction stream systems can exchange their instruction memories or instruction sets, some of which can also be implemented in reconfigurable hardware accelerators. Finally, the system is divided into static and reconfigurable data streams.

While optimizing the types of components as much as possible and trying to reduce the failure of components, the research on the failure mechanism, detection and screening technology, life expectancy, derating stress and other methods of components should be carried out first to improve the inherent reliability of electronic products through failure analysis. When this method is used to

find out which integrated circuit has the fault, first check its peripheral circuit. When there is no fault in the peripheral circuit, it can be judged that the fault is the damage of the integrated block and replace it with a new integrated block. Generally, there is no problem. Understand in detail the whole process, fault history, maintenance history and usage of the instrument, and judge whether the cause of the fault is caused by human or natural factors, so as to provide necessary clues for judging the fault. For this kind of fault, it is usually necessary to replace the damaged electrical components in time. If it is a short circuit fault, it is necessary to check the solder joints and connecting wires and solve it by fixing the solder joints or connecting the connecting wires. For example, instrument fault system is subdivided into circuit fault system and mechanical fault system. When we use system principles to overhaul instruments, we should not only know that the fault system of medical electronic instruments consists of three layers of systems, but also make clear which subsystems each layer of systems consists of and the internal relations between each layer of systems and subsystems. When replacing the potential time scale, record the position of the potentiometer and the number of revolutions. At the same time, use a multimeter to record the resistance value of the potentiometer, so as to avoid too large a difference between the parameters of the new potentiometer and the original potentiometer, thus reducing the adjustment time for matching the parameters of the two potentiometers.

4.2 Reliability Design of the System

Because the hardware architecture can now adapt to the needs of applications. This adjustment is possible both at design time and at run time, allowing optimization of the allocation of computing tasks. Therefore, restrictions on performance, power consumption or usage area can be more effectively realized. By combining the standard top-down design process of static MIMD system with the new bottom-up design process, a novel “meet-in-the-middle” design process was created for RAMPSoC [10]. This design process is shown in Figure 2. From an application perspective, it provides a standard top-down design process for application partitioning and mapping. At the same time, it supports a new bottom-up approach from a hardware perspective, allowing hardware adjustments at design time and runtime using dynamic and partial reconfiguration.

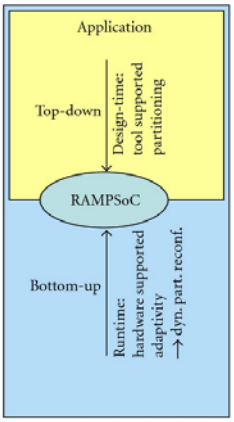

Fig.2 Rampsoc's “Meet in the Middle” Design Flow Method

It is obviously quite difficult to raise the real efficiency of components from six levels to seven and eight levels. It is not necessarily effective to improve the reliability of the whole machine simply by reducing the failure rate of components. As far as system failure is concerned, the reliability of electronic equipment should be improved. When there is no other better way to determine which component is faulty, the static positive and negative resistance values of the integrated block on the board to ground (or other common points) can be re-measured and compared with the original measured values. That is to say, by testing various data, such as voltage, frequency, waveform, resistance-capacitance value, etc. to observe the fault and analyze the difference of parameters, the fault is analyzed from the perspective of quantity. Based on the understanding and comprehensive analysis of the working principle of the instrument, the fault source is determined and corresponding measures are taken. Designers should also understand and

master the failure rules of electronic components, the relationship between performance degradation and stress and time, and carry out tolerance design to lay a good foundation for further improving the reliability level of electronic equipment. According to the relationship between the whole and the part, the relationship between the part and the detail, and the relationship between the system interior and the system exterior environment, the direction and steps of diagnosis should be determined. Generally, starting from the failure phenomena of medical electronic instruments, positive assumptions should be made on various possible causes of the failure. If there is a lot of data in the medical instrument, the restart method cannot be adopted, otherwise the data will be lost and the installation will need to be restarted. Mechanical faults need to be maintained and solved by adding lubricating oil and derusting.

4.3 The Maintainability Design of the System

The highest level of abstraction is the MPSoC level. Here, switching of the entire processor is supported to meet quality of service parameters, such as achieving higher performance or reducing power consumption. In addition, at this level, the application is roughly divided into several tasks. At the same time, make a preliminary decision on the number and type of processors. In addition, as a result of application partitioning, the required communication infrastructure is defined.

The second abstraction layer is the communication layer. Here, the communication infrastructure defined at the MPSoC level is physically established. Using runtime reconfiguration, the communication infrastructure can be modified by adjusting the connections between processors, for example, changing bit width or topology. In addition, routing algorithms can be adjusted. In order to make this adaptation feasible and flexible, the communication infrastructure is transferred to the processor-based abstraction layer, as shown in Figure 3.

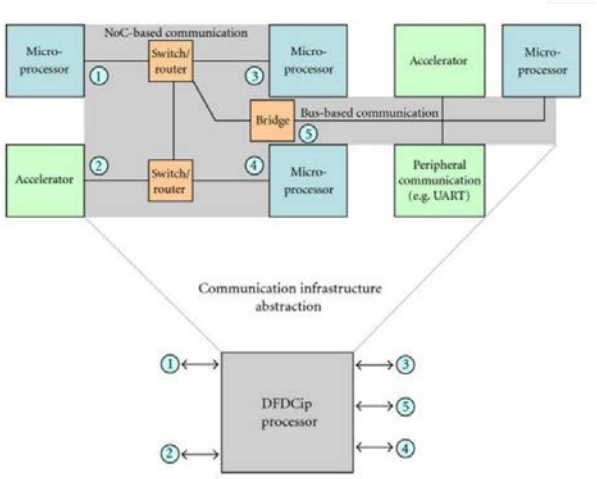

Fig.3 The Communication Infrastructure is Abstracted as a Data Flow Related Communication Infrastructure Processor (Dfdcip)

For complex systems that work for a long time, most cases are actually prevented and repaired before the failure occurs. Only when there is a need to do so can the failure be repaired after the failure occurs. Some medical units did not send special personnel to participate in targeted training when introducing instruments, their own technical strength was weak, and they lacked practical operation experience. They went to work without fully mastering the performance of the instruments, operated a certain key button by mistake, and the operation steps did not meet the requirements, all of which would cause failures. When the instrument fails or the operation method is incorrect, the instrument cannot work normally, and the failure code is displayed or printed. According to the failure code, the voltage, frequency, waveform and other parameters of the instrument can be measured to determine the location of the instrument failure, such as: Electronic sphygmomanometer and electronic blood glucose meter have self-checking function. In order to achieve preventive maintenance in advance, it is necessary to determine the appropriate replacement time, which neither wastes the good products by replacing them prematurely, nor

causes the failure of the whole machine by not replacing the products that will lose performance soon. While continuously reducing the fault range, experiments are carried out on the ultrasonic transmitting and receiving part to ensure that the output waveform is normal. In the process of searching for faults, we should be good at applying engineering logic methods such as induction and deduction, synthesis and analysis, comparison and classification to diagnose faults, and organize strict scientific diagnostic procedures. Only in this way can we quickly find out the logical relationship formed by faults and facilitate the troubleshooting of faults.

5. Conclusion

To sum up, with the continuous development of China's social economy, science and technology have made continuous progress. Science and technology have played a very important role in promoting medical instruments. However, due to the influence of many factors, medical instruments often fail in use. As long as we master the characteristics of the instrument itself, and take targeted measures in combination with its characteristics, we will certainly make medical instruments give full play to their advantages and better serve clinical and human health. After the machine is interlocked, it is not only necessary to measure various parameters through various methods to judge the cause of the fault, but also to be familiar with the structure of the machine, find the circuit and find out a series of easily damaged parts of the problem, which is more conducive to analyzing the fault phenomenon. At the same time, the maintenance results shall be recorded and archived for reference in case of similar problems. Failure statistical analysis of high-performance processors is an essential and important technology to realize high reliability of electronic products.

References

[1] Li Wei, Li Wenjie, Li Shengjun. (2017). Exploration on Teaching Reform of Medical Electronic Instruments and Maintenance Specialty in Medical Higher Vocational Colleges [J]. Modern Vocational Education, no. 4, pp. 40-41.

[2] Shi Chuming. (2019). Analysis and treatment of the prone faults of medical electronic ear thermometer [J]. Medical Equipment, no. 11, pp. 122-123.

[3] Liu Haowu. (2019). Discussion on the failure and maintenance methods of medical electron linear accelerator [J]. Information System Engineering, no. 5, pp. 119-119.

[4] Yuan Lifen, Ning Shuguang, He Yigang, et al. (2018). Fault diagnosis method of analog circuits based on improved SAE-SOFTMAX [J]. Journal of Electronic Measurement and Instrument, no. 7.

[5] Wei Chusong. (2017). Application Practice of Electronic Diagnosis in Vehicle Maintenance Technology [J]. Vehicle Maintenance, no. 9, pp. 23-24.

[6] Long Lianping, Lian Wensheng, Hu Wanyuan. Common faults and treatment measures in power dispatching operation [J]. Electronic Production, 2017 (10): 39-39.

[7] Han Lili. (2019). Design of high-performance data processing module based on AMP architecture [J]. World of Digital Communications, no. 5, pp. 98-99.

[8] Zhang Hailong, Ye Xinchen, Wang Jie, et al. (2018). Taurus High Performance Computing System of Xinjiang Observatory [J]. Astronomical Research and Technology, vol. 15, no. 3, pp. 332-339.

[9] Ming Xu, He Huiwen, Chen Lei. (2018). Application and research of DPDK on domestic Sunway processor platform [J]. Information Security Research, no. 1, pp. 53-62.

[10] An Xin, Zhang Ying, Kang An, et al. (2019). On-line mapping method of heterogeneous multi-core processor system based on machine learning [J]. Journal of Computer Applications, vol. 39 no. 6, pp. 1753-1759.