Research on Interference and Noise Prevention in Medical Electronic Instruments Based on Virtual Instruments

Zhong Jiahong, Xiao Ning

Gannan Medical University; Ganzhou, Jiangxi, 341000, China

Keywords: Virtual Instruments, Electronic Instruments, Interference, Noise

Abstract: in the Application of Medical Electronic Instruments, Interference from External Factors Often Leads to a Decrease in the Accuracy of Detection Results. the Interference and Noise Generated by New Medical Electronic Instruments and Equipment Are More and More and Are Very Harmful. Interference Can Lead to Crash, Incorrect Operation of the Instruments, Image Distortion and Misdiagnosis. in Addition, Interference and Noise Can Also Cause Time-Consuming and Seriously Endanger the Safety of Medical Electronic Instruments and Patients. Therefore, It is Very Important to Effectively Prevent and Reduce the Interference and Noise in the Use of Medical Electronic Instruments. in View of This Situation, This Paper Studies and Develops an Interference and Noise Prevention System for Medical Electronic Instruments Based on Virtual Instruments. the Interference and Noise Prevention System of Virtual Medical Electronic Instruments Can Meet the Daily Needs of Medical Electronic Instruments and Has Important Theoretical and Practical Significance for Experimental Teaching and Academic Research in Universities, Especially for the Development of New Instruments.

1. Introduction

In the Use of Medical Electronic Instruments, the Detected Parameters Are Relatively Weak and Often Interfered by External Factors, Resulting in Operational Errors, Crash and Measurement Errors of Biological Electronic Instruments. Moreover, the Instrument Will Consume More Energy, Reduce the Detection Efficiency, Shorten the Service Life of the Instrument and Even Threaten the Safety of Patients after Being Interfered by Noise and the Like [1]. Interference Can Cause a Crash. Although Digital Circuit Has Stronger Anti-Interference Ability Than Analog Circuit, Once the Interference Exceeds Its Anti-Interference Tolerance, It Will Cause Circuit Logic Error to Enter Dead Cycle and Cause Equipment to Crash. after This Happens, the Device Can Only Be Restarted or Reset [2]. All of These Instruments Use Computer Circuits Based on Digital Processing. They Put Forward Higher Requirements for Power Supply. They Not Only Require Turtle Source Not to over-Voltage and under-Voltage, That is, the Slow Change of Power Supply is Not Big. At Present, the Structure of Most Domestic Noise Network Monitoring Systems is That the Front End Uses a Noise Acquisition Terminal or a Data Acquisition Instrument to Complete the Acquisition of Noise Signals, and Then Uses a Display Screen to Directly Display the Noise Decibel Level [3]. the Current Virtual Instrument Technology is Generally Based on High-Performance Hardware, and Can Complete Measurement and Test Applications by Designing Efficient Software. This Technology Has Been Applied to Testing and Automation Industries. Therefore, Virtual Instrument Technology Can Be Used to Design the Medium Voltage Power Line Channel Noise Generator.

2. Virtual Instrument Technology

Virtual Instrument Technology is Based on Modular High-Performance Hardware as the Development Platform, and Uses Efficient Software Programming to Achieve Measurement and Test Functions [4]. Software Design Can Not Only Create a Customized User Interface, Modular Hardware Can Also Provide a Full Range of System Integration. Therefore, the Most Important Part of Virtual Instrument Technology is Software Design. Roughly Speaking, There Are Two Ways to Combine This. One is to Install a Computer into an Instrument. the Typical Example is the So-

  DOI: 10.25236/ISMHI.2019.127

Called Intelligent Instrument. with the Increasingly Powerful Functions of Computers and Their Shrinking Volume, the Functions of Such Instruments Are Becoming More and More Powerful. At Present, Instruments with Embedded Systems Have Appeared.

As Shown in Figure 1, Virtual Instrument Technology Refers to the Use of Software and Hardware Resources of a Computer to Realize the Functions of Measuring Instruments. the Computer Screen Can Visually and Conveniently Simulate the Control Panels of Various Instruments, Express and Output the Detection Results in Various Required Forms, and Finally Form a Systematic System.

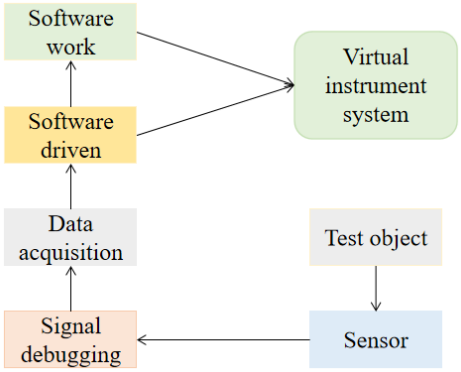

Fig.1 Basic Virtual Instrument System Structure

It adds a layer of software and necessary instrument hardware modules to the general-purpose computer. After acquiring the required signals through the acquisition card, it uses the computer software to realize the analysis and processing of most signals and complete various control and testing functions. In this way, the simplification of functional operation and the simplification of panel arrangement can be realized on each sub-panel, thus improving the correctness and convenience of operation [5]. The display elements and operation elements on the virtual instrument panel are realized by programming, and the designer can design the instrument panel according to the cognitive requirements and operation requirements of the user. Virtual instruments use common hardware, and the main difference between the designed instruments lies in software. This technology exerts the capability of computer as much as possible and has strong data processing capability, so it can be used to create more powerful instruments.

3. Interference, Noise Generation and Related Harm in Medical Electronic Instruments

3.1 Causes of Interference and Noise in Medical Electronic Instruments

During the operation of medical electronic instruments, certain noises will be generated, which will interfere with the operation of the instruments to a certain extent, and will also interfere with the operation of other instruments [6]. In the production of medical bio-electronic instruments, there are certain limitations in related technologies and investment costs, which lead to overall conflicts in the design of many circuits. During the operation of the instruments, noise is generated due to the influence of power filter and resistor. The parasitic oscillation of the circuit forms interference under the conditions of input signal amplitude, temperature, circuit working state, load and the like, which often happens accidentally and is difficult to detect and judge. For example, sometimes it is impossible to distinguish the high-density bright spots and calcified cerebral cysticercosis caused by interference on CT head images. Even with extremely advanced intelligent dynamic ECG equipment, it is sometimes necessary for people to shave off the interference waves one by one. It is customary to call the noise generated in electronic circuits. In principle, any electronic circuit will generate noise, but after the noise in electronic circuits is amplified in multiple stages, it will have an immeasurable impact on the electronic system [7]. Each function of the circuit will also produce serious interference in its function. The parasitic oscillation of the circuit will produce certain noise during the temperature measurement, which will lead to the decrease of monitoring accuracy.

3.2 Harm of Interference and Noise from Medical Electronic Instruments

Medical electronic instruments produce interference, reduce the sensitivity of the instruments, reduce the diagnostic accuracy, which will affect clinical treatment, and also lead to circuit failure. The equipment cannot operate normally. Restart must be adopted. Both the oscillating coil and transformer can accept the signal to form interference. The voltage stabilizer is very sensitive to parameter changes such as power supply frequency. At the same time, the iron core suffers from interference due to non-linear factors [8]. Electronic components can also generate noise, which will affect the normal operation of the circuit. This kind of interference may cause logic confusion in the digital logic circuit, dust or light may interfere with the photoelectric coupling device used for position sensing, or may interfere with the operation of the reference reference voltage of the potentiometer used for position sensing or the buffer amplification circuit of its output signal [9]. The electrons will all move irregularly. The higher the temperature, the more intense the movement of the free electrons. When the free electrons inside the conductor move irregularly, a small current will form inside the conductor. However, because it is disordered, the average total current it forms can be ignored. Common ECG and EMG signals are easily interfered when they are detected. Respiration can also interfere with ECG signals. During the testing by medical electronic instruments, the patient's resistance changes due to intense sweating, resulting in signal interference.

Interference and noise in medical electronic instruments are very harmful. Interference will cause circuit logic errors, thus entering a dead cycle and causing the equipment to crash [10]. Interference can easily cause misoperation of electronic instruments. It is the logic confusion of digital logic circuit, which interferes with its output signal and leads to circuit amplification. Some medical electronic instruments extend the signal acquisition time and increase the number of signal acquisition. The main purpose is to obtain a strong enough signal to offset the adverse effects of interference signals. Examples are the increase of excitation times in MRI scanning parameters and the extension of CT scanning time. Medical personnel will make mistakes under the influence of interference, and digital circuits will have chaotic operation under the influence of interference. In the signal output link, the accuracy of signals will be reduced due to interference. At the same time, electromagnetic elements such as relays will have continuous and repeated characteristics in the working process. When current passes through and is cut off, instantaneous high-voltage reaction will be generated, resulting in instantaneous current with surge characteristics. At the same time, it will interfere with the surrounding lines and vibrate, resulting in noise. After the instrument is disturbed, it will produce great noise and further disturb. Medical electronic instruments fail in noise and interference, and the detection accuracy decreases. Interference and noise in medical electronic instruments affect the use of electronic instruments, affect the accuracy of examination results, and endanger the safety of patients. Interference and noise can endanger the safety of medical electronic instruments and patients. The insulin pump, pacemaker, nerve stimulator and dynamic electrocardiogram extension box that users wear or bury in the human body are all afraid of interference.

4. Prevention and Suppression of Interference and Noise in Medical Electronic Instruments

4.1 Reasonable Design of Circuits for Electronic Instruments

In the installation of medical electronic instruments, the safety must be improved first to ensure that the circuit is grounded and effectively prevent the earth current from generating a large amount of negative pressure, otherwise a large amount of pressure will be transferred to other circuits. Take certain measures to prevent and suppress it. For anti-interference of medical electronic instruments, good grounding is very important. Safe grounding and signal grounding in medical electronic instruments must not be confused to avoid voltage generated by current on the ground line from being added to other circuits through the ground line. The negative feedback signal is sent back to the magnetic amplifier coil, which changes the voltage distribution on the primary of the self-coupling transformer, thus compensating the change of the output voltage. And blocking interference noise, only let the useful signal through. The filtering method generally adopts low-

pass filters of AC power supply incoming line to suppress noise with higher frequency according to the noise object to be suppressed. Transformer installation should be based on the principle of vertical installation to effectively prevent the transformer from being affected by the external environment during operation. Appropriate places should be selected during transformer installation to prevent mutual interference. Shielding is used to suppress interference, especially in magnetic resonance scanning room and electroencephalogram detection room, twice glass and metal shielding materials are used, and elastic metal sheets are added between door frames to give full play to the shielding effect.

4.2 Using Circuit Equipment with Better Performance

In the process of using the instrument, different types of interference signals can be can celled out, thus achieving the effect of reducing interference. In the use of AC power supply, the plug of AC power supply can be unplugged and reversed to reduce the influence of interference on equipment. The isolation technology of optical fiber and transformer to transmit signals is used to suppress interference and noise. A high pass filter is used to string small magnetic beads on the transistor legs to form a filter which is welded to the printed circuit board to form a specific filter to prevent interference. It is connected in series with the tuning capacitor and then connected in parallel to the output terminal. It can directly introduce part of the primary energy into the secondary resonant circuit. Using filtering means to interfere with noise is suitable for occasions where the difference between interference noise and effective signal is large. Among the filtering techniques, there are representative ones such as frequency filtering, amplitude filtering and spatial filtering.

The threshold denoising method in the wavelet domain is similar to other wavelet denoising methods. It also requires wavelet transform to the signal first. Then the wavelet transform value is denoised, and finally the filtered signal is obtained by inverse transform. The difference is that this method directly takes a threshold value for the wavelet transform coefficient and reconstructs the original signal only from the retained larger wavelet coefficient. Therefore, the processing flow of this method is shown in Figure 2.

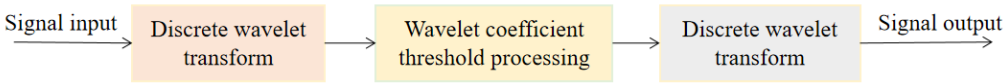

Fig.2 Wavelet Transform Denoising

In the use of the filter, the design of the transistor should be improved, and the filter and the printed circuit board should be used together to ensure that the filter will not be interfered by outside in use. In use, the amplifier should be controlled reasonably and should not be over-amplified, resulting in noise amplification. Each stage of amplifier should not be too high. Do not blindly pursue the high frequency performance of circuit active components, and pay attention to moderate impedance feedback. Devices with good linear characteristics of FET are used to reduce interference and noise.

4.3 Interference and Noise Are Used to Overhaul and Correct the Instrument

There will be a lot of noise and interference in electronic devices, especially when all kinds of devices are running at the same time, the noise will also produce mutual interference, but the location and severity of equipment failure can also be determined through the analysis of noise and interference, providing a certain basis for the maintenance and correction of the instrument. Make the examinee's mind calm to further inhibit interference, correctly use conductive paste, increase the coupling between human physiological signals and examination instruments, and improve the signal changes caused by sweating and the like during examination.

The radiation effect of antenna electric dipole equivalent to poor grounding or reflected voltage at grounding point is called common mode radiation interference. The radiation field generated by the electric dipole near field is formula (1). Where that electric moment of the electric dipole is Idl.

$$\begin{cases} H_f = \dfrac{Idlk^2}{4\pi}\left[-\dfrac{1}{jkr}-\dfrac{1}{(kr)^2}\right]\sin\theta e^{-jkr} \\ E_\theta = \dfrac{Idlk^3}{4\pi\omega\varepsilon_0}\left[-\dfrac{1}{j(kr)}+\dfrac{1}{(kr)^2}+\dfrac{1}{j(kr)^3}\right] \\ E_r = \dfrac{Idlk^3}{2\pi\omega\varepsilon_0}\left[\dfrac{1}{(kr)^2}-\dfrac{1}{j(kr)^3}\right]\cos\theta e^{-jkr} \end{cases} \quad (1)$$

Similarly, the radiated interference field strength in the far field can be obtained as formula (2). Where d1, ECM, and ICM are the cable length, common mode noise, and common mode current, respectively.

$$E_{CM} = 1.256\times10^{-6}\frac{I_{CM}dlf}{r} \quad (2)$$

According to the near-field and far-field calculation formulas, the interference of common-mode radiation noise can be suppressed by changing the influencing factors of common-mode radiation noise when the frequency and detection distance are fixed. Such as shortening signal lines, reducing parasitic capacitance of component pins and adopting EMI filters.

In one cycle, saturation occurs twice on the side column, and the secondary inductor excites the resonant circuit to oscillate with a change of twice the power frequency. If the design is appropriate, this parameter oscillation will continue. Frequency filtering is mainly set according to the difference between true signal and false signal. Frequency filtering can be divided into passive filtering and active filtering, which can be subdivided into band-stop filter, band-pass filter, high-pass filter and low-pass filter. The resonance curve of the parameter oscillation is approximately rectangular, and the edge attenuation is very fast, so the anti-interference capability is strong. Remove the cable of the input signal of the instrument. If the noise of the input device is very large, the fault point of the instrument can be determined, the operation of the amplifying circuit is analyzed, and the noise of the circuit is enlarged by using an amplifier, so that the location and cause of the fault can be determined, and more convenience can be provided in maintenance.

5. Conclusion

To sum up, with the rapid development of modern technology, medical electronic instruments are widely promoted by various pharmaceutical companies. However, the interference and noise in the electronic instruments used in traditional Chinese medicine during the application process have affected the accuracy of the examination results and brought great adverse effects to the inspectors. Therefore, the factors causing noise and interference in medical electronic instruments should be analyzed, and effective preventive measures should be taken to reduce noise. In this paper, virtual instrument technology specifically discusses the noise suppression of electronic circuits from three aspects: filtering technology, electromagnetic compatibility technology and electromagnetic shielding. In practical application, great attention must be paid, and effective measures must be taken to effectively prevent and suppress the interference and noise of medical electronic instruments. Through research, it is found that the interference and noise are especially valuable in the maintenance and correction of instruments.

References

[1] Wang Yunan, Guan Jing, Liu Ran, et al. (2017). Design of Digital Filter Based on Virtual Instrument [J]. Computer Era, no. 3, pp. 34-36.

[2] Zhao Gang. Design of Noise Interference Control System for High Power Electronic Modulator [J]. Electronic Technology and Software Engineering, 2017 (15): 89-89.

[3] Wei Li, Wenqiang Wu. (2017). Analysis and countermeasures of noise interference in HFC cable distribution network [J]. China Cable TV, no. 1, pp. 36-41.

[4] Zhang Lei, Yuan Bo, Cha Chendong. (2019). A sound recognition algorithm for gun control system under strong noise interference [J]. Computer Measurement and Control, no. 6, pp. 104-107.

[5] Hu Baohua, Wu Pingping, Mu Jingsong, et al. (2018). Quantitative assessment method of upper limb spasticity based on sEMG and K-means clustering [J]. Journal of Electronic Measurement and Instrument, no. 6, pp. 53-63.

[6] Wang Yifan, Zhu Guanlin, Wang Zhaoqiang, et al. (2019). Research on suppression of white noise interference on-line monitoring of GIS partial discharge based on improved wavelet threshold [J]. High Voltage Apparatus, no. 3, pp. 37-43.

[7] Zhao Gang. (2017). Design of Noise Interference Control System for High Power Electronic Modulator [J]. Electronic Technology and Software Engineering, no. 15, pp. 89-89.

[8] Xu Yuanbo, Cai Zongxi, Hu Yongbiao, et al. (2018). Application of frequency weighted energy operator and variational mode decomposition in bearing fault extraction under strong noise background [J]. Journal of Vibration Engineering, no. 3.

[9] Xia Zhi, Chen Jianzhong, Niu Yingtao, et al. (2018). Detection method and performance of tracking interference signal in wireless communication [J]. Journal of Terahertz Science and Electronic Information, vol. 16 no. 6, pp. 989-996.

[10] Xu Li, Long Zaiyun. (2017). Research on radiated EMI noise diagnosis and suppression technology based on medical equipment [J]. Automation and Instrumentation, no. 1, pp. 113-115.