Design of Virtual Sphygmomanometer Based on LABVIEWComparison, Reflection, Biological assets, Accounting standard.

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Abstract

Blood pressure is the pressure of circulating blood on the blood vessel wall; which is an important physiological parameter of the human circulatory system. Blood pressure measurement is an important part of medical instrument teaching. In order to improve teaching, virtual instrument technology is introduced into teaching. This paper designs a virtual sphygmomanometer based on LABVIEW for blood pressure measurement. HK2000B sensor is used to build a blood pressure test system; and makes the medical staff have a comprehensive and intuitive understanding of blood pressure signals and other human physiological signals.

Keywords

Sphygmomanometer, LabVIEW, HK2000B sensor.

1. Introduction

The experimental course is an essential part of the teaching process in medical education. Medical equipment experiments are a compulsory experimental course for medical students. Part of the important content of this course is the detection and handling of human physiological signals, through relevant experiments, students not only grasp the characteristics of these signals and the acquisition and handling methods from the theoretical and practical aspects. However, there are always some drawbacks in teaching, for example, the experimental system structure of the relevant medical instrument is complex, and the cost of experimental equipment is high, which leads to the lack of flexibility in experimental teaching, cannot arouse students' interest in learning, and is not conducive to train students' exploration and innovative ability. In order to eliminate the drawbacks of traditional experimental teaching and improve the teaching level, we have carried out a series of teaching reforms on medical instrument teaching; introduce virtual instruments into the measurement system, in which the measurement of blood pressure signals is an important link. Virtual instrument technology utilizes high-performance modular hardware with efficient and flexible software to conduct various tests, measurement and automated applications. This design is one sphygmomanometer developed based on LABVIEW platform; the blood pressure signal is extracted by the data acquisition card and sent to the software system for analysis and processing, it can display common blood pressure parameters and blood pressure waveforms, In addition, if the blood pressure value exceeds the set threshold, alarm is sent, people can also store, recall the collected data.

2. Hardware Design of System

The sphygmomanometer is designed based on the principle of oscillography method. The working process as follows, the mercury sphygmomanometer cuff is wound around the brachial artery of the arm, and the blood pressure oscillation wave sensor is directly inserted into the cuff to directly contact the skin, and then the blood pressure wave sensor is connected with stainless steel and mercury sphygmomanometer valve, finally, the Korotkoff sound is monitored by a mercury meter. The measurement system sends the collected blood pressure wave signal to the designed virtual instrument LabVIEW software platform for analysis and processing through the data acquisition card and HK2000B sensor. Block diagram of the system is shown in Fig.1.

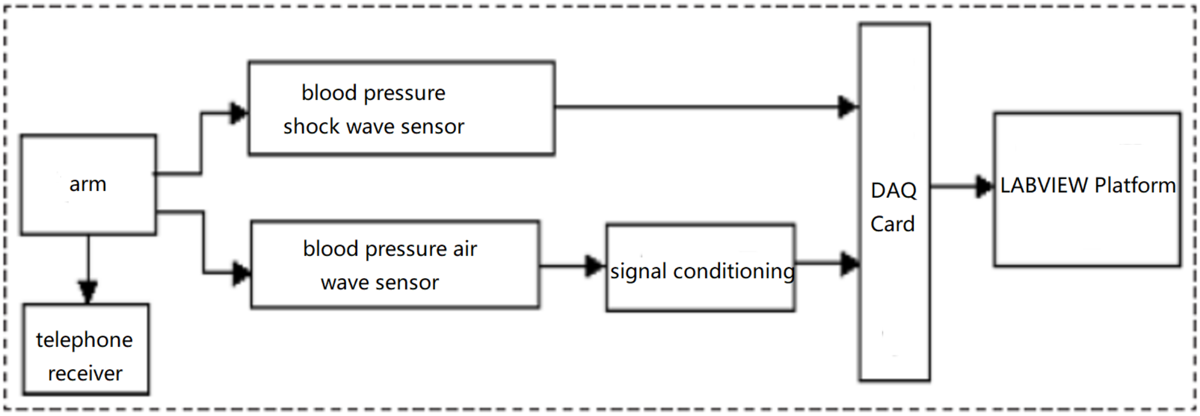

Fig.1 Block diagram of the system

The task of the hardware design part of sphygmomanometer is to collect and regulate the blood pressure signal of the human body. The main working process is as follows: there is a constant current source circuit consisting of operational amplifier IC2 and its external resistor circuit, the output of the operational amplifier outputs a constant current, and the current is supplied to the second terminal of the pressure sensor SE1, temperature compensation circuit mainly consists of an operational amplifier IC4, the output of the sixth terminal of the operational amplifier IC4 is connected to the fifth end of the operational amplifier IC5, the pressure sensor SE1 receives the blood pressure signal for piezoelectric change, and the converted voltage signal is output to the pin 2 and 3 of operational amplifier IC5. The circuit amplification multiple can be adjusted by changing the size of the potentiometer RP1, and finally the drive output is realized by differential operation amplification, and the change of the pressure is reflected by the voltage change of the AI2.

In the hardware circuit, the driver circuit of the sensor primarily uses the precise and low noise general operational amplifier OP07 and Texas Instruments TL431 stabilivolt diode; the output of the sensor is input to the prime amplifier in a differential mode, and the prime amplifier adopts AD620 with low price, high common-mode rejection ratio and good reliability. The pressure sensor selects HK2000B sensor with simple structure and high cost performance.

The HK-2000B sensor developed by Hefei Huake Information Technology Co.Ltd is an analog signal with output voltage; it is subjected to analog-to-digital conversion through internal AD acquisition of the microcontroller to obtain a digital signal.

The HK-2000B sensor developed by Hefei Huake Information Technology Co.Ltd is an analog signal with output voltage; it is a singular singular singular singular singular singular singular singular singular singular singular Integrators a highly integrated component (PVDF piezoelectric film), sensitivity temperature compensating component, temperature sensing component, and signal conditioning circuit into the sensor the piezoelectric principle collects signals, simulates signal output, and outputs a complete pulse wave voltage signal, this product is mainly Used for cardiovascular function testing.

The main features of the HK-2000B sensor are as follows:

1. Analog voltage signal output;
2. High sensitivity;
3. Strong anti-interference ability;
4. Large overload capacity;
5. Good consistency;
6. Stable and reliable performance, and the service life is long;

HK-2000B sensor technical indicators:

1. Power and voltage: 5 ~ 6V DC;
2. Pressure range: -50 ~ +300mmHg;
3. Sensitivity: 2000uV/mmHg;
4. Sensitivity temperature coefficient: 1×10-4/°C;
5. Accuracy: 0.5%;
6. Repeatability: 0.5%;
7. Delaying: 0.5%;
8. Overload: 100 times.

The microcontroller processing circuit was designed; the main core chip adopts STC12C5A60S2 microcontroller with 8-bit A/D conversion function produced by Atmal Company, the 22MHz crystal oscillator is used to realize overclocking operation, which can not only quickly calculate the operation data, but also can be programmed according to actual demand conditions. The circuit eliminates the A/D conversion circuit part and adopts the principle of successive approximation, namely the AD contains da, when the input voltage is Vin, the highest bit of da is 1, namely 0.5Vref is compared with the input signal, if the input is greater than 0.5Vref, then the output of the comparator is 1, and the highest bit of da is 1, on the contrary, the highest bit of DA is 0, and the highest bit of DA is 0, after 8 comparisons, eight 01 data is obtained to complete the ad conversion. It is simple and clear, convenient and quick to use, reduce the incidence of failure and easy to use. The display section uses a 2.4-inch FTF LCD display. Moreover, the button is set to complete the adjustment of the blood pressure to better display in the screen for easy observation.

This design uses HK-2000B integrated sensor to build a pulse detection system, and initially realizes the display function of blood pressure. The STC12C5A60S2 microcontrollers was used to design the hardware circuit of the pulse signal acquisition and display system, and the related software was written, realize the display of the pulse wave waveform and the adjustment of the waveform amplitude value, and realize the display of blood pressure and the adjustment of the amplitude value of the waveform.

The hardware circuit part mainly completes the collection of blood pressure signals and the conditioning of signals. The specific design requirement is the differential voltage signal is generated by the pressure sensor; the constant current source circuit is constructed by the amplifier and the voltage regulator tube, and is supplied to the pressure sensor; the signal amplifying circuit is composed of the amplifier and the temperature compensation circuit and the driving circuit. The main task of the blood pressure analog signal detection and conditioning circuit is to detect the cuff pressure signal and the pulse wave signal and use it as the input signal of the data converter. This part circuit is composed of a pressure sensor circuit, differential amplifying circuit, and filter circuit. The pressure sensor circuit measure the pressure in the cuff, outputs a mixed signal of the cuff pressure and the pulse wave; the differential amplifying circuit performs the first-stage amplification of the differential signal outputted by the pressure sensor, and sends it directly to the converter as a cuff pressure signal, the filter circuit filters out signals such as interference noise.

The blood pressure signal is first collected by a pressure sensor, then appropriately amplified and conditioned before being sent to the input El of the digital conversion module. The characteristics of human physiological information are low-frequency weak signals, generally the order of llV-mV, the frequency range is 0-300Hz, and the signal-to-noise ratio is low. Therefore, the sensor must select high sensitivity to effectively extract human physiological signals and convert them into electric signal.

Various devices in biomedical signal testing systems often generate noise that has an impact on measurement accuracy. In order to improve the signal-to-noise ratio, a filter can be used to attenuate these noises, namely remove some frequency components that are not related to the measurement by filters, filter out unwanted low-frequency, high-frequency or incoherent signals, or get signals for certain frequency segments as needed.

The filter can be composed of passive components such as resistors, inductors, capacitors, etc., it is called passive filters; it can also be combined with active components and passive components, it is called active filters. The active components in the active filter can use a transistor or an integrated operational amplifier. In general, the active filter of integrated operational amplifiers is characterized by low loss, small size, light weight, etc., and can provide a certain gain and buffer, therefore, active filters composed of integrated operational amplifiers are particularly widely used. The filter used in this system uses the form of a second-order active filter.

The blood pressure measurement system collects the signal through the sensor, and then directly sends it to the acquisition card through the amplifier, the acquisition card is connected to the computer through the USB interface, the USB interface is not only the power supply interface of the acquisition card, but also the interface for the data communication between the acquisition card and the computer. The collected signals are sent to the computer in real time for signal display and analysis processing. The data acquisition of is design uses LabJACK U12 to collect blood pressure signals, and then transmits the collected blood pressure signals to the LabVIEW virtual instrument blood pressure measurement system for software processing.

3. Software Design of System

With the rapid development of microelectronics, computer technology, communication technology, etc., new measurement methods, measurement theory, measurement fields and new instrument structures have emerged, and the concept of traditional instruments has been broken in many aspects. Especially the computer-based instrument system and computer software technology are closely integrated, which is an important direction of current development. There are two ways to do this: one is to load the computer into the instrument and become an instrument with an embedded system and an intelligent instrument; the other way is to put the instrument into a computer, namely virtual instrument.

The virtual instrument refers to computer-based hardware infrastructure platform that is designed and defined by the user, which has a virtual operation front panel, and the instrument test function is implemented by software. Virtual instruments break through the hardware-based model of traditional electronic instruments. In fact, the operator can use the virtual panel created by the mouse to operate the hardware platform of the system, just like using a dedicated measuring instrument. The virtual instrument is a computer instrument system, which uses the display function of the computer display to simulate the control panel of the traditional instrument, outputs the measurement result in various ways, and uses the powerful software function of the computer to realize the data calculation and signal acquisition, analysis processing by the FO interface. thereby completing various required test functions.

The virtual instrument includes two basic elements of hardware and software. The instrument hardware is the peripheral circuit of the computer, it forms the hardware environment of the virtual instrument system with the computer, the hardware device and interface can be various PC-based built-in function cards, serial ports, general-purpose interface bus interface cards or other various programmable external test equipment; and application software gives the system a unique function. The device driver software is a driver that directly controls various hardware interfaces, the virtual instrument communicates with the real instrument system through the underlying device driver software, and displays the operation elements corresponding to the real instrument panel on the computer screen in the form of a virtual instrument panel.

Software design is the key to virtual instrumentation. It directly affects the performance and function of virtual instruments, moreover the quality of software determines the difficulty of instrument upgrade. At present, LabVIEW has become a leading development platform for data acquisition, data analysis, etc., has a large number of users in the world. Because the development of this system selects LabVIEW as the virtual instrument software development platform, it can make more considerations on how to implement the system function in actual development, without paying too much attention to the details of program, thus greatly improving the system development speed.

This design uses the LabVIEW platform to design data acquisition, amplification filtering, spectrum analysis, and display systolic blood pressure, diastolic blood pressure, mean pressure, pulse rate, and blood pressure waveforms, and then handle the collected blood pressure signals to obtain useful physiological information. The blood pressure signal passes through the sensor and the necessary conditioning circuit and then enters the LabVIEW platform through the data acquisition card for software processing, thereby obtaining the desired physiological information.

The software measurement system of the blood pressure signal LabVIEW virtual instrument can obtain the clinical information with clinical significance such as systolic blood pressure, diastolic blood pressure, average pressure and pulse rate, which is of great significance for the clinical diagnosis of certain blood pressure-related diseases. Moreover, the blood pressure measurement system designed with LabVIEW virtual instrument is more flexible, convenient for function expansion and update, convenient to use and cost-effective.

4. Conclusion

Based on the basic principle of oscillometric method, this paper completes the construction of sphygmomanometer based on virtual instrument with the related hardware. From the rssults, the system basically realizes the initial design requirements, can collect blood pressure signals, and can achieve measure of systolic and diastolic blood pressure. This topic introduces the idea and method of virtual instrument technology into the development of medical instrument experiment teaching, puts forward the concept of virtual medical instrument experiment, constructs and applies the method of combining virtual and reality in the development practice of virtual instrument experiment. Most of the functions in the traditional measurement system that need to be realized by the hardware circuit are converted into software, this is a high-efficiency, high-quality development of virtual instrument experiments, which not only saves costs, but also avoids waste caused by repeated maintenance, LabVIEW has powerful extended functions and common function modules, which has practical significance for the development of medical instruments.

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