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A Detection Device for the Signs of Human Life in Accident

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Abstract: A detection device for the signs of human life in accidents is a device used in emergency situations, such as the crash site. the scene of natural disasters, the battlefield ruins .it designed to detect the life signs of the distress under the injured ambulance vital signs devices. The device can on human vital signs, including pulse, respiration physiological signals to make rapid and accurate response. After some calculations, and after contrast to normal human physiological parameters given warning signals, in order for them to make timely ambulance judgment. In this case the device is required to do gymnastics convenience, ease of movement, power and detection of small flexible easy realization. This device has the maximum protection of the wounded safety significance.

1. Introduction

The detection device for signs of human life in accident is suitable for detecting the vital signs in frontier emergency (such as emergency center, ambulance), accident disaster rescue, and troops battlefield frontier ambulance. At present, many research units and enterprises at home and abroad have set up related projects, put a lot of manpower and material resources research and development of various monitoring equipment, the overall is moving towards multi-parameter, miniaturization, electronic, intelligent and network [1].

For such cases, design a detection equipment of accurate, not easy to pollution, simple and efficient is of great importance. In the accident scene it can be timely measurement of human vital signs (heart rate, pulse, blood pressure, breathing, etc.) and quickly feedback to the medical staff. Not only timely provide a basis diagnostic data for the site rescue but also for the admission treatment, greatly increased first aid efficiency and maximum to save the lives of the wounded health.

2 Purpose and content

Vital signs [2] is used to determine the patient's indications for severity and critical degree. There are heart rate, pulse, blood pressure, breathing, body temperature and so on. Medical staff need to fully understand the meaning of vital signs, but also timely grasp the changes of patient's vital signs in order to take measures for treatment timely and effective. Therefore, in clinical practice it needs some auxiliary detection equipment of vital signs to help doctors diagnose the patient's condition for timely treatment.

Based on this, this paper design and production of a simple, low-cost human vital signs monitoring devices. Atmega8 chips used for the main part, Piezoelectric sensors collecting physiological signal AD620 signal amplification, user-friendly LCD interface output display. At the scene of an accident, the rapid and accurate detection of the wounded vital signs (pulse). Diagnosis of medical staff to provide the required information.

The design uses Atmega8 chip to achieve a dual channel[3] detection device for pulse wave and body temperature life. Using a piezoelectric sensor through a channel to achieve the measurement of human pulse wave, and integrated temperature sensor to detect human body temperature. The signal acquisition from piezoelectric sensors needs filter by AD620, shape and adjust to the microcontroller interface, display output with LCD after processing the programs. The corresponding system is divided into signal extraction module, zoom filter module, single chip and display module, as well as software design and power module. This article focuses on the hardware interface section.

3 Hardware design

3.1. System program demonstration and selection

The four methods[4] of human body physiological signal detection are respectively Photoelectric sensor method, Ultrasonic reflection detection method, Temperature sensor - sensing life signal method and Direct measurement of piezoelectric sensors. Among them photoelectric sensor method is mainly used to measure the number of pulse beat. For the amplitude of vibration, due to differences elasticity of human skin, the error is large, and thus we give up this program in this design. Ultrasonic reflection detection method, in this area the Fourth Military Medical University has developed products. But it bulky and difficult to achieve.

The main form of human radiation is invisible infrared radiation. The higher temperature, the stronger radiation. Infrared rapid temperature detection products is based on the above principles. We designed a pulse signal acquisition device by means of a piezoelectric accelerometer. Through the hardware and software filtering can eliminate the interference of external vibration.

The sensitivity can be determined by the following formula:

$$\frac{d_{33}}{\sqrt{(1/\omega R)^2 + (c_1 + c_2)^2}} \tag{1}$$

Which d_{33} is the piezoelectric coefficient. Since the pulse signal is a low frequency signal, the sensitivity is sufficiently high as long as the input impedance of the amplifier is large enough. The signal output from Piezoelectric sensing is weak, need to be amplified. According to the equivalent circuit of piezoelectric sensing, its output can be either voltage or charge. So the preamplifier also has two circuit forms: the voltage amplifier and the charge amplifier. The input voltage of the preamplifier is:

$$U_{im} = \frac{dF_m wR}{\sqrt{1 + (wR)^2 (C_e + C_i + C_C)}} \tag{2}$$

As can be seen from the above equation, the amplitude of input voltage is not only related to the force, but also with the frequency of measured signal, input resistance, capacitance. When $w >> \frac{1}{\sqrt{R(C_e + C_i + C_c}}$,the input voltage of preamplifier is independent of the frequency of the signal. Since the pulse signal is very weak and the frequency is low, the input resistance of amplifier is required great. In addition, the variation of the cable capacitance C also affects the changes of the input voltage of the preamplifier. Therefore, the pulse signal should not use voltage amplifier.

In summary, we use the three method and four method to achieve a detection device of human pulse and body temperature.

3.2. Circuit design

The diagram of system block is shown in Figure 1:

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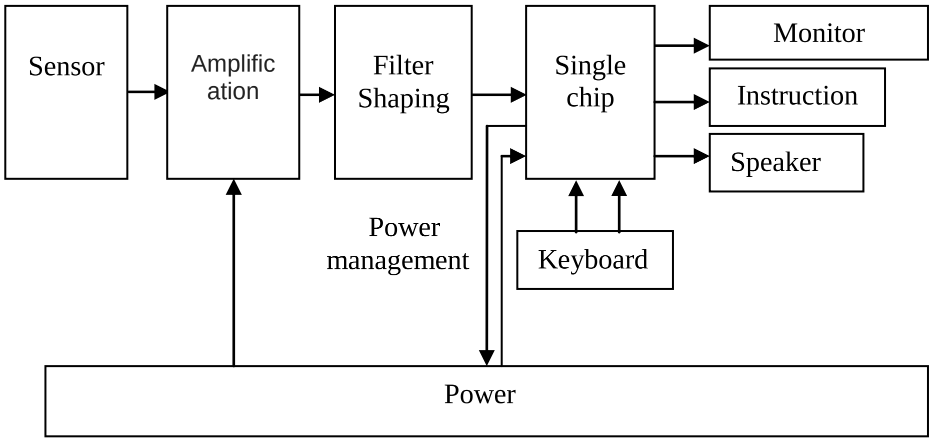


Figure 1. Diagram of System Block

The system consists of power supply part, amplifier part, filter part, keyboard part, display, sound and light alarm part and the microcontroller part.

- Power supply part: Because operational amplifier needs use dual power supply, so use 9V carbon battery. Reduce it to 5V after regulator module 7805 and then use the max232 interface chip to produce positive and negative 10V dual voltage.
- Amplifier part: Using AD620 amplifier, it has high accuracy and high input impedance, and it is very appropriate with piezoelectric sensors. It needs only one external rheostat for adjusting the gain, suitable for a variety of equipment, simple and convenient.
- Amplifier part: The design is mainly to detect the pulse and low demand for the accuracy of the waveform, so use ordinary RC low-pass filter can meet the requirements.
- Keyboard part: With two ordinary buttons, red stop, green start, easy to operate.
- Display: Using LCD1602 display, the information is more rich, user-friendly.
- Sound and light alarm part: Signal is not normal, the red light, speakers high frequency alarm; When the signal is normal, the green light, the speaker regular sound with the pulse beating.
- Microcontroller part: The core of the system. SCM is responsible for the signal processing, calculation, control LCD display, sound and light alarm, accept and deal with key information, management power and so on. Where the power management part of the design is a bright spot.

3.2.1. Power module. The design uses 9V carbon battery, reduced voltage to 5V with use of 7805 regulator module. Because the AD620 operational Amplifier is used, dual power supplies are required. And then use the RS232 interface chip to produce positive and negative 10V dual voltage, you can ensure that the microcontroller part display module driver and amplification filter circuit to work properly. In the actual test, we found that if the output voltage directly connect with 7805 to provide power to the other module, the power will not be fully utilized, so we designed a following power management circuit after improvement, shown in Figure 2:

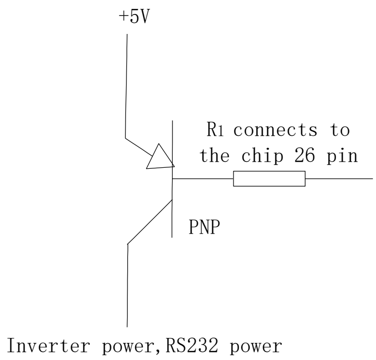


Figure 2. Power management circuit

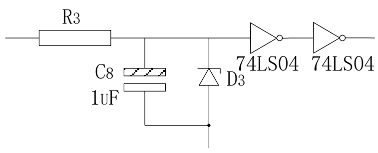


Figure 3. Filter and shaping part

When the system is working normally, the program controls the 26-pin of the microcontroller output a low level, so that the PNP transistor turns on, the amplifier and shaping circuit is energized. The microcontroller output high level when pause or sleep mode, PNP transistor cut-off, amplifier and shaping circuit stop working, and the system is in power-saving state.

When 5V voltage change into ±10V voltage, the general chip is difficult to meet the requirements. Combined with the usual experience, RS-232 interface chip can achieve this function, and has high efficiency, so use max-232 as the power chip.

3.2.2. Zoom filter module.The output signal of basic hardware circuit is weak, need to be amplified. According to the equivalent circuit of piezoelectric sensing [5], its output can be either a voltage or a charge. So the preamplifier also has two circuit forms: which is voltage amplifiers and charge amplifiers. The input voltage amplitude of voltage preamplifier is:

$$U_{im} = \frac{dF_m wR}{\sqrt{1+(wR)^2(C_e+C_i+C_C)}} \tag{3}$$

From the above, the input voltage amplitude is not only related to the force, but also with the frequency of the measured signal, input resistance, capacitance. When

$$w >> \frac{1}{\sqrt{R(C_e+C_i+C_c}} \tag{4}$$

The input voltage of preamplifier is independent of the frequency of the signal measured. Since the pulse signal is very weak and the frequency is low, the input resistance of amplifier is required large. In addition, the variation of the cable capacitance C also affects the change of input voltage. Therefore, the pulse signal should not use voltage amplifier. The output voltage of the charge amplifier is:

$$U_0 = \frac{-Aq}{\sqrt{C_e+C_c+C_i+(1+A)C_f}} \tag{5}$$

When $(1+A)C_f >> (C_e+C_c+C_i)$, The output voltage of the charge amplifier is independent of the cable capacitance and the frequency of measured signal. Therefore, the piezoelectric sensor for measuring the pulse signal uses a charge amplifier [6].

The body's pulse signal change vibration signal into a charge signal by the piezoelectric sensors. And then through the charge amplifier conversion, the amount of charge will be converted to a very weak voltage signal. This voltage signal can change into digital signal by the amplification of voltage amplifier. This also meet the requirements of ADC.

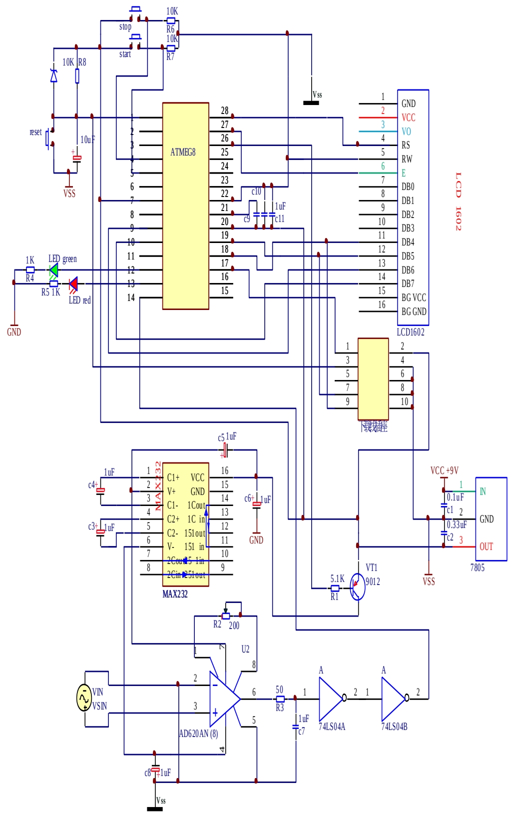
There is negative pressure after filter, and sometimes the peak is too high, we added a 5.6V regulator tube to protect the follow circuit. In order to achieve the better filtering effect, the design plus two-stage reverse shaper behind the regulator tube,as shown in Figure 3.

3.2.3. Microcontroller and display module. LCD display use 1602 module, the module comes with character set and 11 instructions. Considering the reliability of the circuit, input instructions and data by using four bus mode divided twice times.

The requirements of microcontroller is got on A/D conversion and the display module driver. The I/O distribution of hardware part is: The timer / counter receives and input signal; The button and the indicator use two I/O port respective; There are total six I/O port for display using four bus and plusing control signals. There is also a power management control port. Also set up a 10-pin download line interface for facilitate its programming.

4. Design circuit diagram and debugging

System design circuit shown in Figure 4, getting on the proteus software simulation according to the above selection, and then debug the hardware part. Debug waveform as shown in Figure 5.



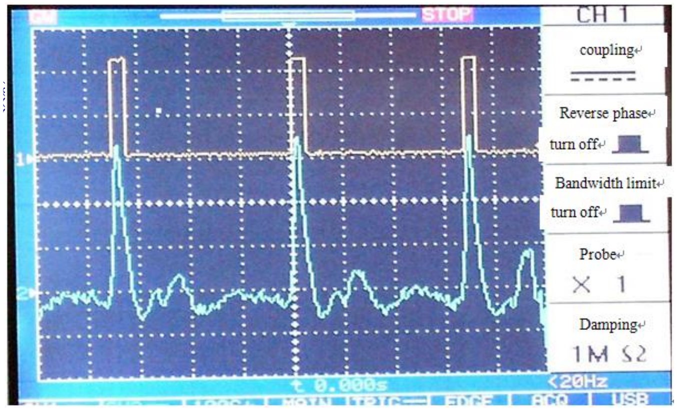


Figure 4. System design circuit diagram **Figure 5.** Pulse graphics after amplification of the signal

When debugging, the components and chip sockets are not inserted into any chip. Starting from the power input, use the multimeter to detect the output of the 7805 in turn. And then detect 16 pin of the max232 socket, 7 pin of the microcontroller socket, 2 pin and 3 pin of the LCD socket, , 14 pin of the 74LS02 socket. Under normal circumstances these pins have a voltage of 5v, and then the power of AD620 appears (output of the max232) ±10V voltage.

Acknowledgement
School-level key issues: Research and Practice of Ubiquitous Learning System Based on Mobile Terminal

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