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Design of ECG Device Based on STM32

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Abstract. A plan of ECG acquisition, analysis and processing system based on STM32 is proposed in the system, and its hardware and software design are completed. The core of the system is ECG acquisition circuit, which is to complete the signal extraction. The system is a typical biomedical signal collecting- processing one, which processes weak signals in strong noise background. Because of the impact of noise and interference, the front-end acquisition circuit needs to have higher performance.

1. Introduction

With the progress of society, the development of economy and the gradual improvement of people's living standard, the aging of population in China is becoming more and more serious, and the incidence of diseases such as heart disease is also rising. There is a great threat to people's health. Related data show that the number of deaths due to cardiovascular and cerebrovascular diseases in China accounts for nearly half of the total number of deaths[1]. About 160000 patients are undergoing stetting each year, with an annual growth rate of more than 1/5. In our country, the annual cost of cardiovascular and cerebrovascular diseases is 300 billion Yuan. Due to the limitation of test methods, the prevention rate, treatment rate and control rate are still very low. Prevention rate is the key factor to prevent and cure cardiovascular and cerebrovascular diseases, and effective ECG monitoring instrument is a tool to accomplish this task.

2. Whole system structure

ECG detector structure as shown in fig 1, mainly composed of the following several modules.

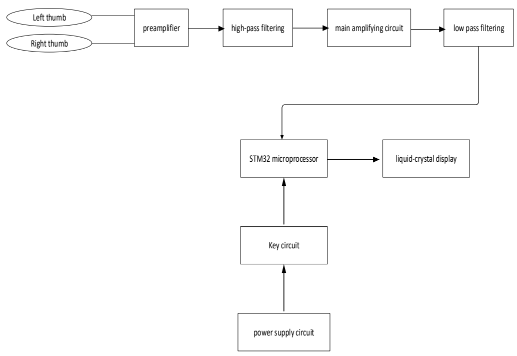

Fig. 1. The structure of ECG detector

3. Signal acquisition circuit

3.1 Design of preamplifier circuit

When the bioelectric signal is acquired in the body surface, a large amount of radio signals are converted into electrical signals along with the useful signals. If these signals are not processed or sent to the analog-to-digital conversion ends, a large number of common - mode noise signals will inevitably be generated, so that a large number of common - mode noise signals will inevitably be removed at the input of the sensor, and the instrumentation amplifier is the most suitable for implementing this function. The AD622 instrumentation amplifier of Analog Devices, Inc. is used in this design, as shown in Fig 2.

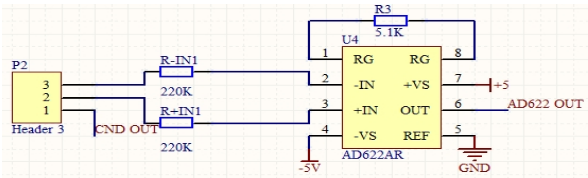

Fig. 2. Preamplifier Circuit

AD622 has the characteristics of low noise, low drift, high common-mode rejection ratio and high input impedance. Its voltage amplification can reach 1000 times electrode polarization voltage, and the maximum polarization voltage can reach 300mV. In order to prevent the preamplifier from entering the cut-off or saturation state, AD622 has many advantages such as low noise, low drift, high common-mode rejection ratio and high input impedance. The magnification must be limited, where the gain G is about 10:

$$G = 1 + 50 / R3 \tag{1}$$

The external resistance R3 is a precision wire-wound resistor with a resistance value of 5.1 k Ω, and the voltage amplification ratio is G = 150 / R3 / 10. 8.

3.2 Baseline drift processing

A great deal of medical data and practice show that the human breathing and measuring the contact between the electrode and the human body will cause certain noise. The characteristic of this kind of noise is that the frequency is less than 0.5 Hz, so it is called baseline drift. If this kind of signal exists for a long time, it will accumulate in the backend circuit and cause a large DC offset. A high pass filter with a lower frequency of 0.5 Hz is used to eliminate the baseline drift signal. The circuit is shown in fig 3.

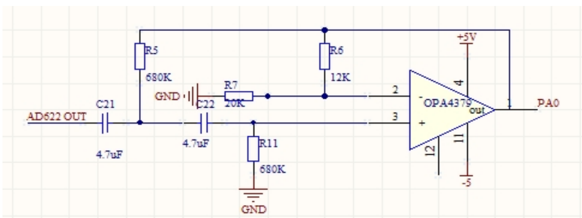

Fig. 3. Baseline drift processing circuit for ECG signal

3.3 Main amplifying circuit

The amplitude of ECG signal is generally about 1mV, and the input range of A/D conversion is about 1V to about 5V, so a phase I proportional amplification circuit is designed to improve the gain after high pass filtering. The circuit is shown in fig 4.

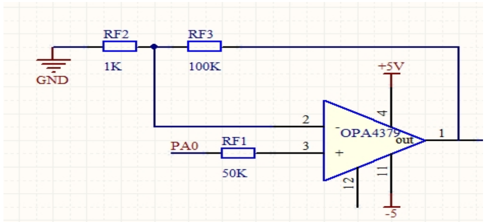

Fig. 4. Main amplifier circuit

3.4 Low pass filtering

The related theory of bioelectronics proves that the frequency range of ECG signals is 0.05 ~ 100Hz or more. For ECG signals, they are all out-of-band signals, so we must use filters to filter out these out-of-band signals, in order to ensure the correctness of the digital-analog conversion results. According to the signal measured during the experiment and the spectrum analysis data obtained by the spectrum analyzer, a low-pass filter with a cut-off frequency of 100Hz is used to filter the input signal to remove the out-of-band noise signal. The circuit is shown in fig 5.

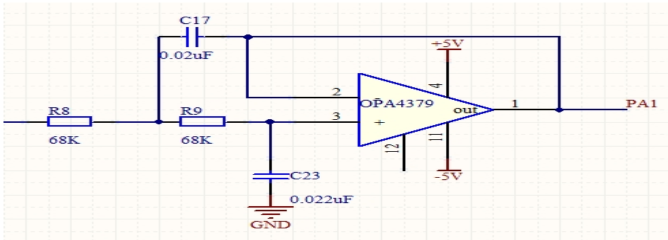

Fig. 5. Low-pass filter circuit

3.5 Power-supply module

The ECG acquisition circuit needs the working voltage of STM32 of earth 5V power supply to be 3.3 V. this design is powered by 9V battery, the medium and negative 5V voltage can be produced by 7805 and 7905. It is generated by AMS1117 using a combination of external inductors and capacitors to provide liters of positive and negative voltages to meet the operational amps. Fig. 6 is a typical application.

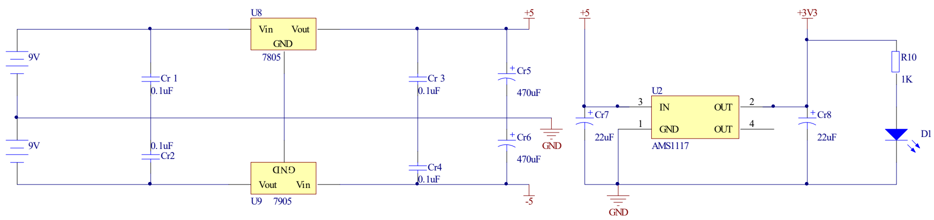

Fig. 6. Power module

3.6 Key and display module

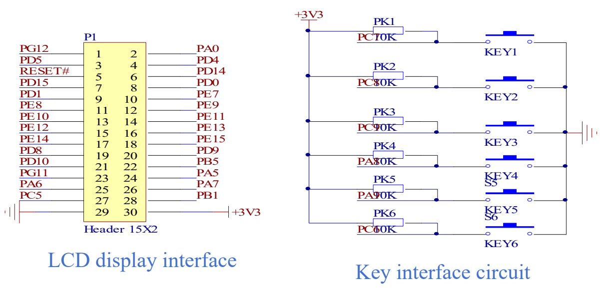

Fig. 7. keystroke and display module

The design of the key module uses five keys, which are defined as upper, lower, left, right and middle keys. The first four keys are to select the LCD display object which is set or accessed, and the middle key is to determine the key. The 3.2 inch true color TFT LCD touch screen is used in this design. Fig. 7 is its application.

4. Overall flow chart of system software

The overall flow chart of the system software is shown in Fig. 8.

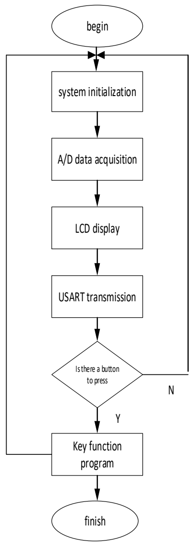

Fig. 8. overall flow chart of system software

5. Conclusion

This system realizes the portable miniaturized ECG monitoring system. Firstly, the electrocardiograph products on the market are investigated, and their advantages and disadvantages are analyzed, and their advantages are used in the system. Their whole design method is studied, the related circuit design of electrocardiogram instrument is consulted, the scheme of this system is designed, and the feasibility of its realization is discussed. Secondly, the choice of chip is also very important. In this paper, STM32 chip based on Cortex-M3 with high performance and price ratio is chosen as microprocessor. The MCU can accomplish the required functions of the system very well. Be familiar with after software and hardware development environment, the whole systematization is divided into several modules and realized step by step.

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