Dynamic ECG Detection System Based on ARM

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Abstract

Objective to design a portable ECG(electrocardiogram) Monitoring System for the purpose of analysing a period of ECG signals,this ECG Monitoring system is based on the ARM kernel. This paper introduces the design of the components of the ECG Monitoring System. Its principle is leading by the method of getting ECG signals from the body surface, then using the filter to filter out high frequency interferences, and then helping filter out the power interferences further by a 50 Hz trap filter. Finally, in order to get digital ECG signals, we use the MCU A/D conversion to realize. The ECG signals are shown on the OLED screen, and stored in the large capacity memorizer. As an innovation, ECG signals are transfered to the PC or APP via bluetooth interface. So we can analsy a period of ECG signals both on the computer and the ARM kernel.

Keywords

ECG,ARM Kernel,Signals Sampling,Large Capacity Memorizer,Bluetooth.

1. Introduction

According to the statistics, millions of people died because of the cardiovascular disease on average each year in the world, and 44% of them happened in China. The cardiovascular disease in China has become a main disease threatening people's life. The reason who many patients died is failing to find out the cardiovascular disease timely so that they delayed to have treatments. The prevention of heart system disease and diagnosis has become the top issue facing the medical profession today. Internationally, large amounts of people have realized that the research on the laws of the characteristics of ECG signals, and the prediction of some relevant pathological changes and diagnosis in time accurately can help decrease the rate of death. Therefore, providing doctors the effective auxiliary analysis is important and meaningful. In order to facilitate the rule of a period under different conditions of ECG signals, and has an analysis and forecasting, this system not only have the function of daily ECG monitoring, but can also store ECG signals in the large capacity memorizer, and analyse on PC to achieve the goal of getting the characteristics of ECG signals.

2. Design of Hardware System

The overall design scheme of the system as shown in Fig.1. The Circut of ECG Sampling as shown in Fig.2.

Single-polar line method: to detect a local ECG changes of the heart, using a known as the detection polar placed closely to the heart of chest,and another polar which is known as the reference polar placed in the body of the far away from the heart. Detecting the change of the electrode potential in parts is the heart of the local voltage change. Considering the ECG signals is very weak, amplitude at 0 to 4 mV, frequency band width of about 0.05-100 Hz and in the process of sampling, there are many disturbance signals, such as power frequency of 50 Hz, people's respiratory electricity biological noise, the electrode polarization voltage, noise, thermal noise and the noise of instrument itself and other disturbance signals. Especially the influence of the power frequency interference, on subsequent characteristic waveform detection and analysis, is very big. The power frequency

interference, which causes a lot of influence on subsequent characteristic waveform detection and analysis, either. So, requesting the preamplifier part of signals's amplifying circuit have high enough common mode rejection ratio which are referred to as CMRR. Object to achieving this goal , the gain we choose is about 800 ~ 1000, the frequency response is 0.05 ~ 45 Hz, the input impedance is 5.1 ~ 10 MOhm, and the common mode rejection ratio is greater than 80 dB. Except that ,it will make low noise and low drift. In addition, noticing the portable monitor characteristics at the same time, we should pay attention to the characteristics of the volume so in choosing op-amp ,and reducing the power consumption and volume of the machine.

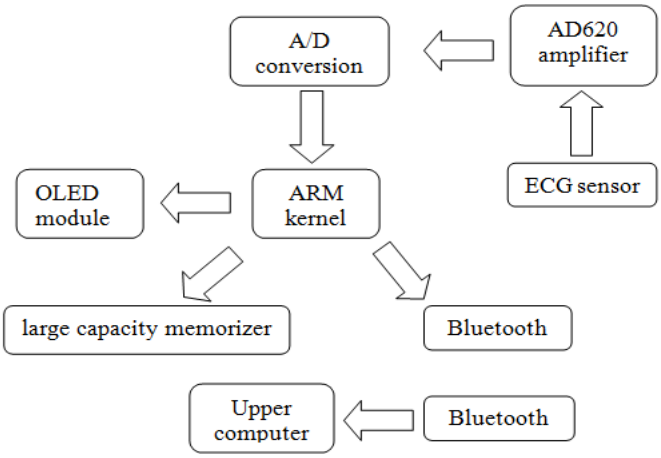

Fig.1 The Hardware Structure

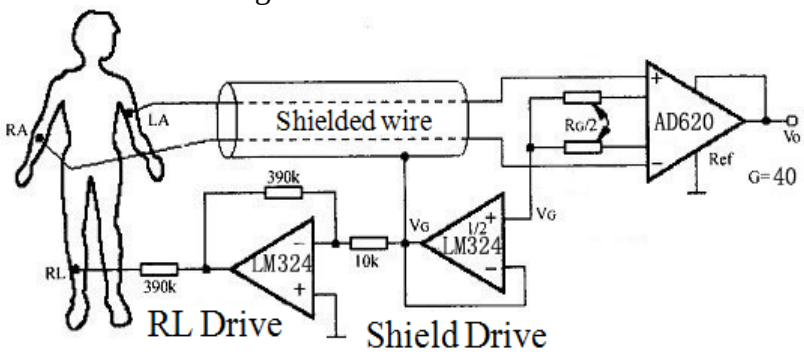

Fig.2 The Circut of ECG Sampling

Preamplifier module adopts the instrumentation amplifier AD620 chip. Its internal integration minimum common-mode rejection ratio can reach 100 dB, and its adjustable gain from 1 ~ 10000 times by an external adjustable resistance. The differential mode inputting impedance up to 10000 mega is much greater than the design requirements, which can fully guarantee the total circuit differential mode to input impedance of 5 mega. Additionally, there are low noise and low input offsetted current characteristics about the AD620. Especially, the indicators of chip in low frequency band are outstanding, which is applicable to 120 KHZ signals amplification. Concerning the noise produced by electrodes when contact the DC polarization voltage (especially when using ordinary copper sheet as contact electrode), polarization of electrode voltage is a differential mode signal because of the saturation of op-amp. Offset zero can be created by the REF of AD620. Although improving the first level of the amplifier gain is beneficial to reduce the noise, and considering the effect of polarization potential, the circuit gain of instrument amplifier should not be too large. The lowest possible frequency components of ECG signals are only at 0.5 Hz (corresponding to heart beat 30 times/min), but in order to reduce signals linear distortion caused by the phase shift, ECG signals amplification circuit of low cut-off frequency must arrive to 1/10 of low cut-off 0.05 Hz of ECG signals.

After that,using the high-pass filter to filter the noise above 150 Hz, and using notch filter circuit with 50 Hz to filter the frequency interference. Circuit diagram is shown on Fig.3.

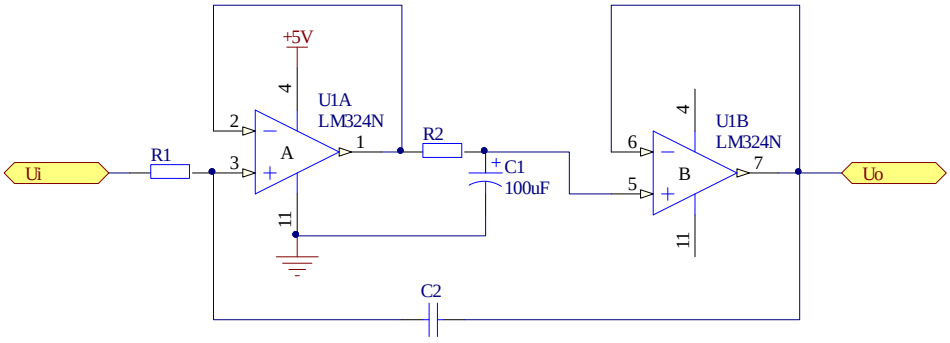

Fig.3 A Low-pass Filter Circut

Then using the A/D conversion of STM32 sampling signals, LCD display module shows ECG waveform,and through bluetooth module of the system' transmit data to the APP or the PC software so that to realize real-time display and the computer analysis of ECG signals. At the same time, the system will be automatically deposited in the large capacity memorizer module to facilitate the playback of ECG signals and be beneficial to analyse a period of time ECG signals under different state.

3. The Software Structure

For the realization of the software, we divided the project into different parts, such as the LCD displaying, A/D sampling, wireless data communication, data storaging, data analysis, mobile phone APP written, the PC software writing of upper machine and so on, then constitute the whole system. Program execution block diagram is shown in Fig.4.

4. Text of the System

We do the final text for the system and will get the waveform from the experimenters. Displaying waveform by PC, mobile phone APP, and OLED, and analysing the data of ECG and waveform, this system can work regularly in measuring the actual waveform. They are shown in Fig.5,Fig.6 and Fig.7 below.

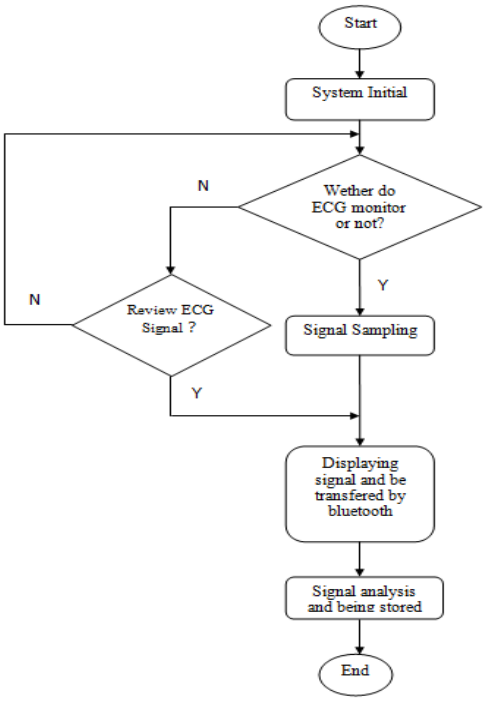

Fig.4 The Software Structure

5. Conclusion

The design innovation points of the paper are designing a portable ECG detection system. The system has the characteristics of high input impedance, high common mode rejection ratio, low noise, low temperature drift and high signals-to-noise ratio, etc. It has the characteristics of low cost, small size, less power consumption and easy to carry. It can be used to test the real-time ECG signals. With the advantage of signals playback, storage and the signals' analysis, and has achieved the multi-functional characteristics through the mobile phone, PC to display the signals. The test results also show that the amplifying circuit meets the actual requirements and can be applied to ECG monitor.

Fig.5 The Waveform of Upper Computer

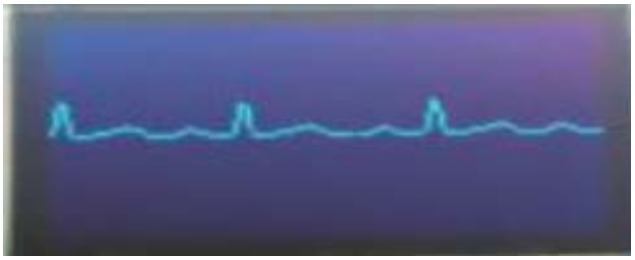

Fig.6 The Waveform of OLED

Fig.7 The Waveform of APP

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