SUGISAKA MASANORI

Journal of Advances in Artificial Life Robotics
Vol. 3(2); September (2022), pp. 73–76
ON LINE ISSN 2435-8061; ISSN-L 2435-8061
https://alife-robotics.org/jallr.html

Research Article

Design of household ECG detector based on STM32 chip

Tianyi Zhang, Huating Liu
College of Electronic Information and Automation, Tianjin University of Science and Technology, 300222, China

ARTICLE INFO

Article History
Received 22 November 2021
Accepted 06 September 2022

Keywords
Signal acquisition
ECG
Digital signal process
STM32

ABSTRACT
ECG monitoring instruments occupy an important position in the medical field of application. According to its electrocardiogram, it can be judged whether the basic function of the heart is normal, whether there is some kind of heart disease, etc. Traditional ECG monitoring devices have the disadvantages of being large and not portable. In this paper, a portable home ECG monitor is designed to overcome these disadvantages. In this paper, we designed a portable infrared induction heart rate measurement device, using STM32C8T6 as the core chip, to complete the extraction and processing analysis of ECG signals. The complete set thus composed can make basic diagnosis of the collected data and is successfully applied to daily life of family..

1. Introduction

With the progress of society, economic development and the gradual improvement of people's living standards, the aging of the population is becoming more and more serious. The incidence of heart disease is also on the rise[1]. However, due to the limited testing locations and methods, it has become difficult for ordinary people to prevent, detect and seek medical treatment in a timely manner. Timely detection and treatment is a key way to reduce the emergence of heart-related diseases. Effective and convenient ECG monitoring instruments are a powerful tool to accomplish this task [1],[2].

Conventional ECG monitoring devices are bulky, expensive and not portable, and can only record ECG activity while the patient is lying down for a short period of time, obtaining very little information. In order that ECG signal detection is not restricted by fixed occasions and can be diagnosed more conveniently, a design of a portable ECG signal detection system is proposed.

Portable monitoring device can monitor and store data anywhere and anytime. This paper mainly designs a portable ECG device, which collects ECG signals through sensors, performs processing operations such as filtering and enhancement by STM32 chip, and finally is displayed by the display. It has the features of low price, small size, easy to carry and easy to use.

2. General Design

In this paper, we design a household ECG detector, which combines embedded technology, digital signal processing technology and signal acquisition technology in one. It can complete the function of ECG signal extraction and analysis.

The whole system consists of six modules: signal acquisition module, signal process module, keypad module, display circuit module, PC communication module and MCU module. The system structure schematic diagram is shown in Fig.1.

The heart rate signal of the subject is collected by the front-end electrode, and then the heart rate signal is transmitted to the ECG acquisition circuit for a series of

Corresponding author's E-mail: zhangtianyi085@163.com web: www.tust.edu.cn

operations such as pre-amplification, main amplification, high and low pass filtering, etc. A compliant set of ECG signals will be obtained. The system then sends the ECG signal to the STM32 ADC for AD conversion once it is obtained.

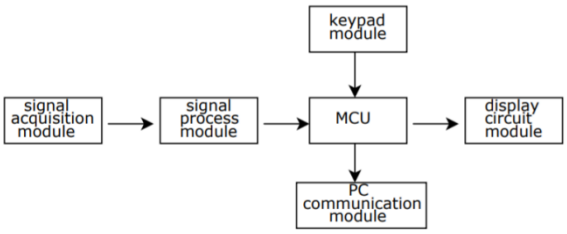

Fig. 1. The system structure schematic diagram

The system control chip adopts STM32 and the display adopts TFT-LCD. Its touch function plus a small number of keys can establish a good human-computer interaction environment, which can be displayed and played back in real time by LCD. The acquired data can be transferred to a PC for signal analysis.

3. System Hardware Design

The hardware selected for the system includes the following two aspects: choice of processor and the human-machine interaction interface.

3.1. *Choice of processor*

Processing speed, complexity of the completed tasks, complexity of peripheral circuits, production costs and high-power consumption are factors that cannot be ignored when choosing a processor.

Considering the above aspects, we finally chose STM32F103C8T6, a new 32-bit ARM core processor chip from STMicroelectronics, from the STM32 family. The main control chip is shown in Fig. 2.

Fig. 2. STM32C8T6 chip

In the design, the processor is responsible is responsible for five parts, including signal acquisition, signal filtering and processing, display of ECG waveforms, data storage, and communication. The processor is the core in the whole system.

3.2. *Human-machine interaction interface*

Human-machine interface is a device for communication between human and machine, which can transmit human commands to MCU and also let the device display the information we want to know. Color, power consumption and size are the factors to consider when choosing a human-computer interface display, and these factors must be selected in combination with actual use.

According to the above points this design chose 3.2 inch true color TFT LCD touch screen, with 320 * 240 pixels, 260,000 colors, 16-bit parallel interface, it can be directly driven by AVR, ARM7, STM32 and other MCUs. The screen-related parameters are as follows:

- Resolution: QVGA 240 x 320
- Size: 3.2 inches
- Controller: IL9320
- Touch screen: 4-wire resistive type
- Pins: 30PIN
- Backlight: 4 LEDs in parallel

The touch screen is shown in Fig. 3.

Fig. 3. The touch screen

4. System Circuit Design

In the circuit design, this design adopts Pre-amplifier circuit, right leg driver circuit, filter circuit, trap circuit and power supply circuit to form an overall system circuit. These circuits are able to process signals efficiently and greatly improve the functional effectiveness of the device.

4.1. *Pre-amplifier circuit*

The pre-amplifier circuit has to perform the function of differential signal amplification. This part of the circuit is the first link in the entire acquisition circuit, and has a greater impact on the subsequent links, so it is very important to choose a suitable differential operational amplifier chip. The following points are generally considered in the selection.

- Gain
- Frequency Response
- Common Mode Rejection Ratio
- Input Impedance
- Low noise, low drift

4.2. *Right leg driver circuit*

Due to the large amount of external interference to humans, the capacitive coupling between the ECG electrodes and the power lines generates displacement currents[1].The right leg drive circuit is often used to remove the common mode signal from the input amplifier and eliminate interference noise.

We use a right-leg drive circuit, which can have a suppressive effect on 50Hz interference and does not come at the expense of losing the frequency component of the ECG signal.

4.3. *Filter circuit and trap circuit*

To filter out interference, we need to design a bandpass filter that allows ECG signals with frequencies from 0.05 Hz to l00 Hz pass through. This causes signals outside this range to be attenuated significantly.

The active bandpass filter is used in this design. The bandpass filter is composed of a high and low pass filter with a high pass filter as of f=0.03Hz and a low pass filter as of f=110Hz.

Considering that the right leg drive circuit cannot completely eliminate the interference signal, this design adds a 50Hz trap circuit to further eliminate the industrial frequency interference. The experimental results show that the signal waveform is clear and distinctive by high and low pass filtering followed by trap circuit.

4.4. *Power circuit*

The power supply circuit design mainly considers which type of power supply device to use, the input and output voltages, the output current, and the control state. The ECG acquisition circuit requires a ±5V power supply, the STM32 operates at 3.3V and this design is powered by a 7.2V battery.

5. System Software Design

The system software is divided into two broad parts. The two parts are as follows:

(1) Lower computer software, i.e. STM32 application. It mainly completes the acquisition of ECG signals, signal filtering, RTC module, LCD display and serial communication, etc.; (2) the upper computer management software. Its function is to complete the reception and processing of data, which mainly includes the reception, display and storage of data [2].

Software Flow Diagram is shown in Fig. 4.

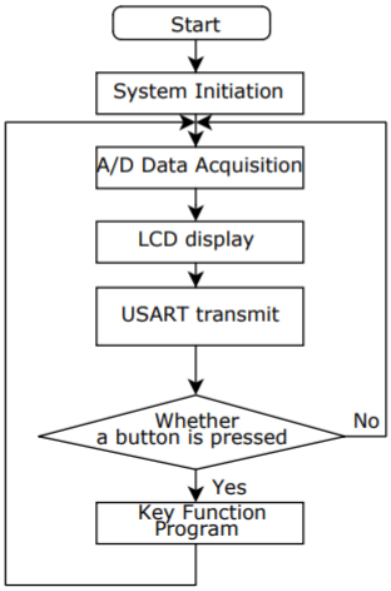

Fig. 4. Software Flow Diagram

6. Conclusion

The system designed in this paper is a portable and miniaturized ECG monitoring system, and the STM32 chip based on Cortex-M3 was chosen as the microprocessor to maximize cost savings. Overall, we

designed a portable ECG signal collector based on STM32 chip with easy operation, flexible mobility and low cost.

It is easy to carry the characteristics of storing data, can complete a long period of ECG monitoring, and real-time ECG waveform display through TFT-LCD color LCD, through the key to make the system has a good human-computer interaction interface. According to several experiments and trials, the household ECG detector is able to collect human signals and process and display them well, which is helpful for users to monitor the heart status anytime and anywhere.

References

1. Zhou J . Elimination of Power-line Interference from ECG Signals. *Journal of Biomedical Engineering Research*, 2003.
2. Wang D X , Wang G J . Development of a portable ambulatory ECG monitor based on embedded microprocessor unit. *Space Medicine & Medical Engineering*, 2005, 18(3):196-200.

Authors Introduction

Ms. Tianyi Zhang

She is a second-year master candidate in Tianjin University of Science and Technology, majoring in brain-computer interface, machine vision.

Ms. Huating Liu

She is a second-year master candidate in Tianjin University of Science and Technology, majoring in flashboarding.