Human heart rate detector based on photoelectric volume

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Abstract

At present, the most effective and intuitionistic method for detecting human heart rate is to measure, observe and analyze ECG, extract effective data of ECG, waveform and other information can help doctors to analyze and diagnose. In this study, the human pulse signal was collected by photoelectric volume principle, and the heart rate signal was obtained indirectly, and the heart rate signal was displayed by wireless transmission. The results show that the instrument can collect the related signals from the human body surface by using the heart rate sensor, transmit the data to the single chip microcomputer after the processing of the conditioning circuit, and select the display mode after further processing by the single chip microcomputer. Data can be transmitted through Bluetooth module to the mobile phone APP display, or display the processed data by the display screen.

Keywords

Heart rate measurement, Photoelectric volume, Wireless Bluetooth device, Adroid.

1. Introduction

At present, there are mainly two kinds of non-contact measurement methods for heart rate, such as the use of ultrasonic detection technology and IPPG technology, and the pulse diagnosis method is the main method of contact-type measurement. Using piezoelectric sensor to measure ECG and so on. Some scientists abroad are beginning to study the technique of IPPG (image photogrammetry), which can be used to capture the different color of blood by using modern computer instead of contact-measuring method. Thus, the information closely related to human heart rate is obtained. Based on the photoelectric sensor and the principle of photoelectric volumetric method, a human heart rate detector based on single chip microcomputer is designed in this paper. A series of tasks such as amplifying, filtering, rectifying, A / D conversion and so on are completed by using different integrated chips to convert the signals into voltage signals, and then the main control chip is used to process and calculate. It can detect human heart rate quickly and accurately at any time and anywhere.

2. Measurement of Human Heart Rate by Photoelectric Volume

The basic principle of measuring pulse rate by photoelectric volumetric method is that when the blood vessel pulsates, the transmittance of various parts of the body changes, so that pulse measurements can be carried out and irradiated into human subcutaneous tissues by emitting red or infrared light. The detected signals are then transmitted via wireless Bluetooth to various types of Android phones or to LCD displays.

2.1 Overall System Design

The design adopts the sensor to collect the data, collects the corresponding signal and converts it to the output of the voltage signal of millivolt level. After the voltage signal is adjusted, the processed signal is sent to the single-chip microcomputer and then sent to the display module.The information is displayed by the corresponding display screen, and the data is transmitted to the mobile phone by the wireless communication module at the same time, which is convenient to analyze and observe the data.As shown in the following figure, the overall scheme block diagram of the system is as follows:

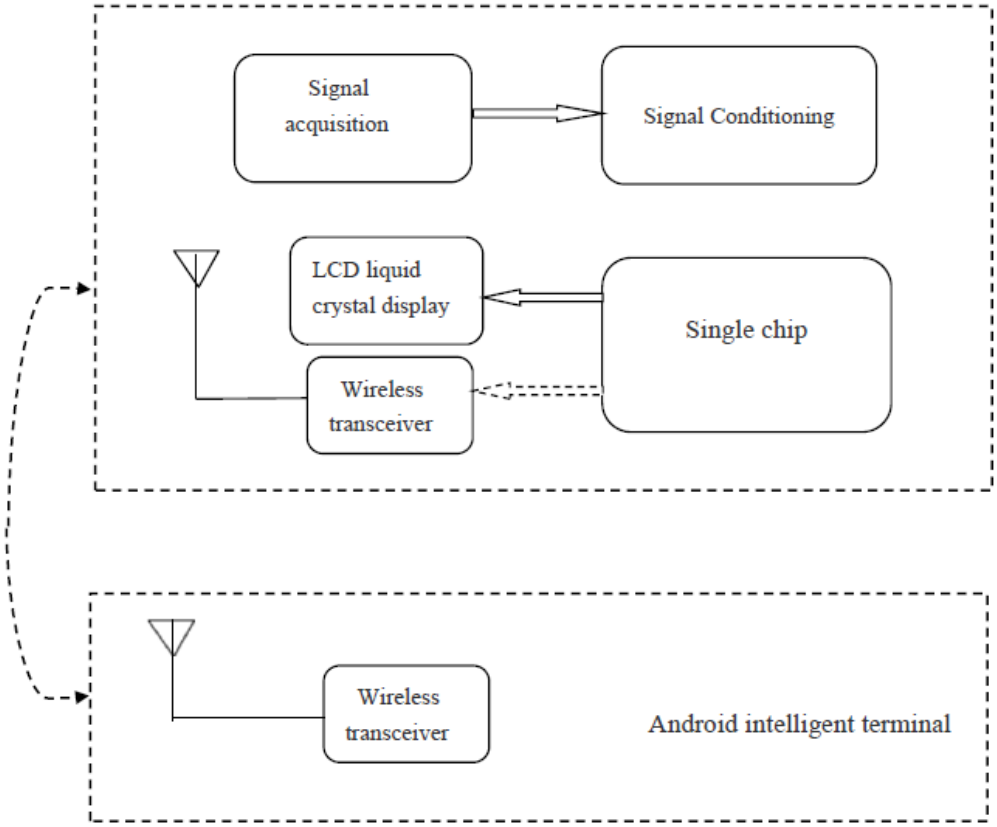

Fig. 1 Overall design of system

2.2 Circuit Design

2.2.1 Single Chip Microcomputer Minimum System

The STC12C5A60S2 microcontroller encapsulated in the system is PDIP40, with 40 pins. The circuit diagram of the MCU is shown in the following figure:

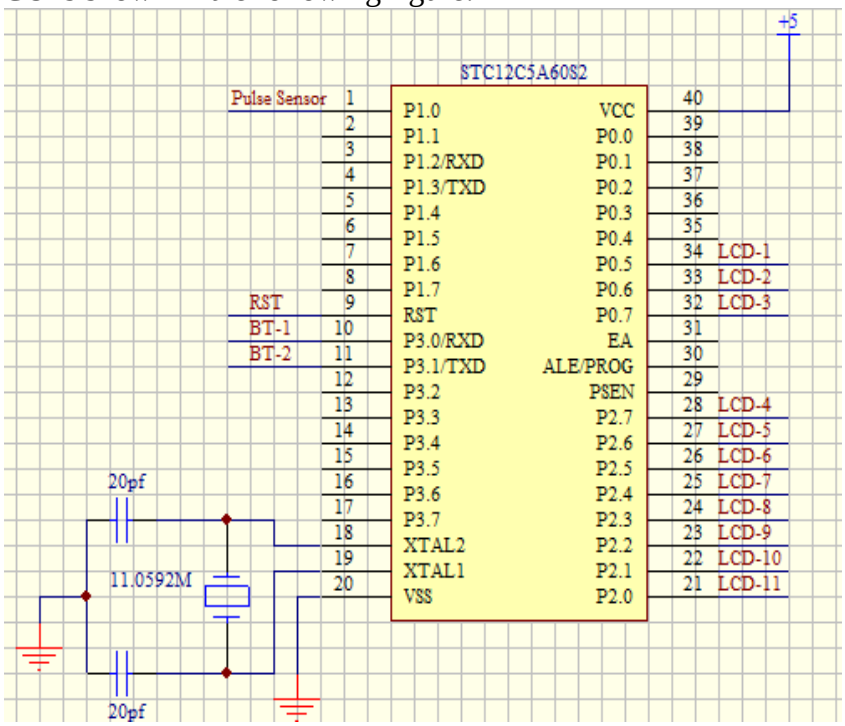

Fig. 2 Single chip microcomputer circuit diagram

The 10th and 11th legs of the single chip microcomputer are the data receiving end and the data sending end respectively, which are connected with the data sending end and the data receiving end of

the Bluetooth module.The 18th pin is the output end of the internal clock circuit inverse amplifier, one pin of the external crystal oscillator, the 19th pin is the input end of the internal clock circuit inverse amplifier, and the other pin of the external crystal oscillator, The crystal oscillator. P0. 5, P0. 6 and P0. 7 ports of external 11MHz are used as address / data multiplexing bus. There is a pull up resistance in the low 8 bit address line. P2 port is used as an input and output port in the system. It is 8 bits quasi-bidirectional port and is connected to the data input port of LCD.

2.2.2Wireless Communication Circuit

HC-05 Bluetooth module has six pins, including data receiving end and data sending terminal [. The schematic diagram of the connection between the Bluetooth module and single chip microcomputer is shown in the following figure.

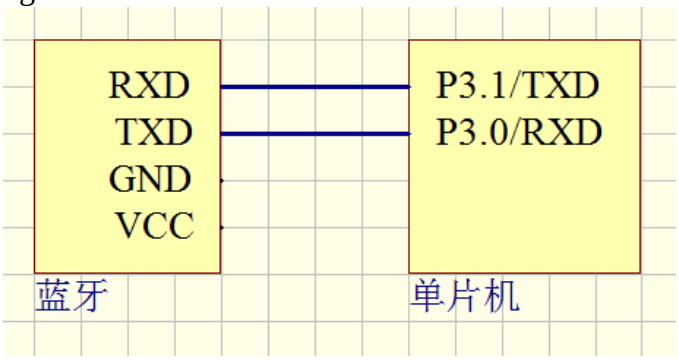

Fig. 3 The connection between the Bluetooth module and the single chip microcomputer

2.2.3Display Circuit Design

The enable signal terminal, read / write selection terminal and data command selection terminal of LCD1602 are connected to P0.5 P0.6 and P0.7 ports of single chip computer, respectively. The P0 port of single chip microcomputer is used as address data multiplexing bus.The data of the low 8-bit address line .LCD is connected to the P2 of the single chip microcomputer, where the P2 port is used as the input / output outlet, and the principle diagram of the connection between the 8-bit quasi-two-way port .LCD1602 and the single-chip microcomputer is shown in the following figure.

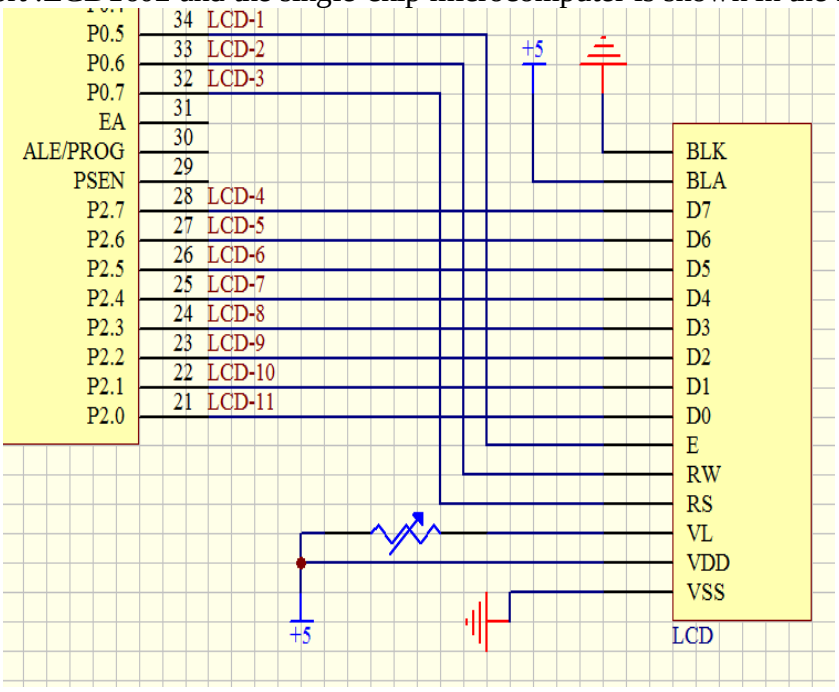

Fig. 4 The connection between lcd1602 and much

2.3 Software Design of Heart rate Detection System

2.3.1Main Program Design

In the software design of human heart rate detector system, it is required to collect heart rate signals from sensors and send mobile phones via Bluetooth serial port after data processing by single chip microcomputer. On the other hand, it is transmitted directly to LCD display data by single chip computer. The system follows the principle of top-down design, and the main process of the system software is shown in the following figure:

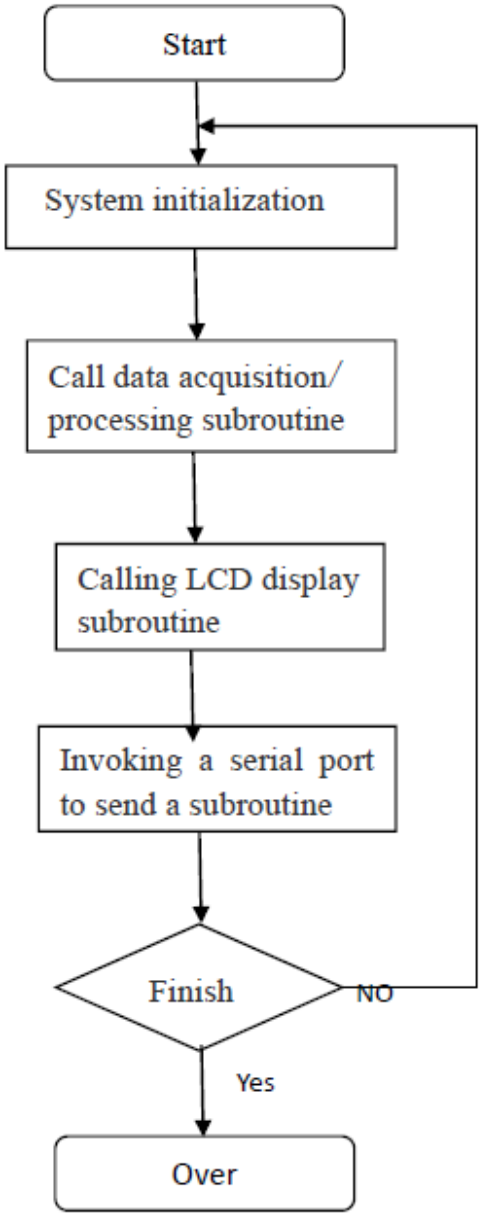

Fig. 5 System software master flow

2.3.2Data Processing Subprogram Design

The heart rate sensor selected by the system contains filter circuit and amplifying circuit. The selected microcontroller also contains ADC, and the data processing subroutine mainly carries on A/D transformation to the signal.

2.3.3Communication Subroutine Design

(1) Configuration of Bluetooth Module

HC-05 embedded Bluetooth serial port communication module has two working modes: automatic connection and command response. The system adopts command response mode, and the parameters

of configuration module must enter AT command mode. First, the Bluetooth module is connected to the PC by a USB to serial port line, and the serial port debugging assistant is opened on the PC, which starts to set up.

(2) Mobile phone Bluetooth connection

After the configuration of HC-05 Bluetooth module, the phone can install "Bluetooth Serial Communication Assistant" to connect with the module, open the Bluetooth Serial Communication Assistant, search the Bluetooth device, and then enter the matching code to communicate.

(3) LCD display subroutine

LCD and other displays are composed of multiple display points, each display points display different colors to achieve the function of displaying text and pattern. The data end of LCD1602 is connected to the I / O port of single chip computer. The flow chart of the LCD display section for data transmission is shown in the following figure.

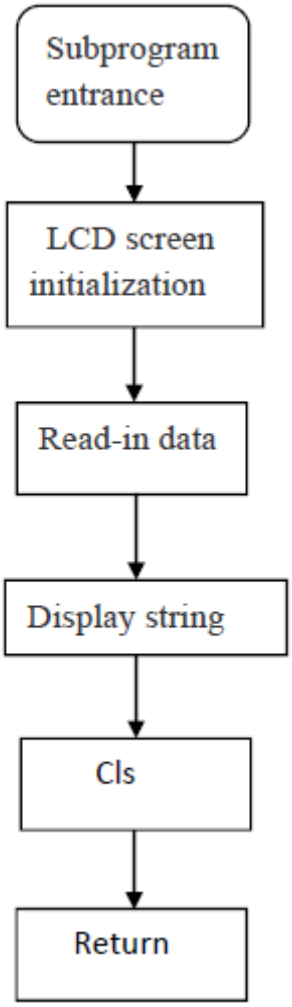

Fig. 6 LCD display flow chart

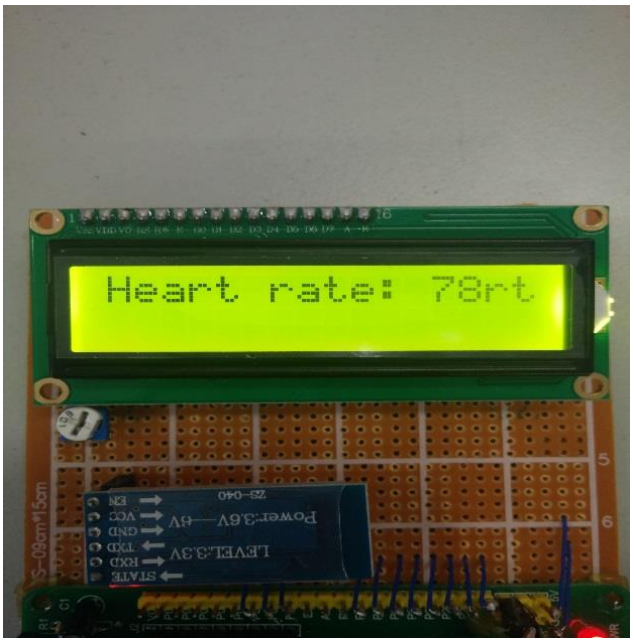

Fig. 7 LCD display chart

2.4 Software Test

The Keil software is used in PC to carry out the expected target execution of the source program. By tracking the program, breaking point, checking the variables, changing the value, the executing steps of the source program are simulated from the inside to ensure the reliable operation of the program. In this study, the MCU control data acquisition part LCD display part, wireless transmission part of debugging.

(1) Compatibility testing

Because Android is open source and free to use, there are many mobile phone manufacturers that use Android system in the market now, and the difference of hardware produced by different manufacturers is very great. This may cause some compatibility problems in Android application software.

Table. 1 shows the system compatibility test results

NO.	Brands	Model	Bluetooth connection	Data display
1	OPPO	Find7	success	Normal
2	OPPO	N1mini	success	Normal
3	HuaWei	MT7-CL00	success	Normal
4	Samsung	GALAXY5	success	Normal

The connection is as shown in the figure below:

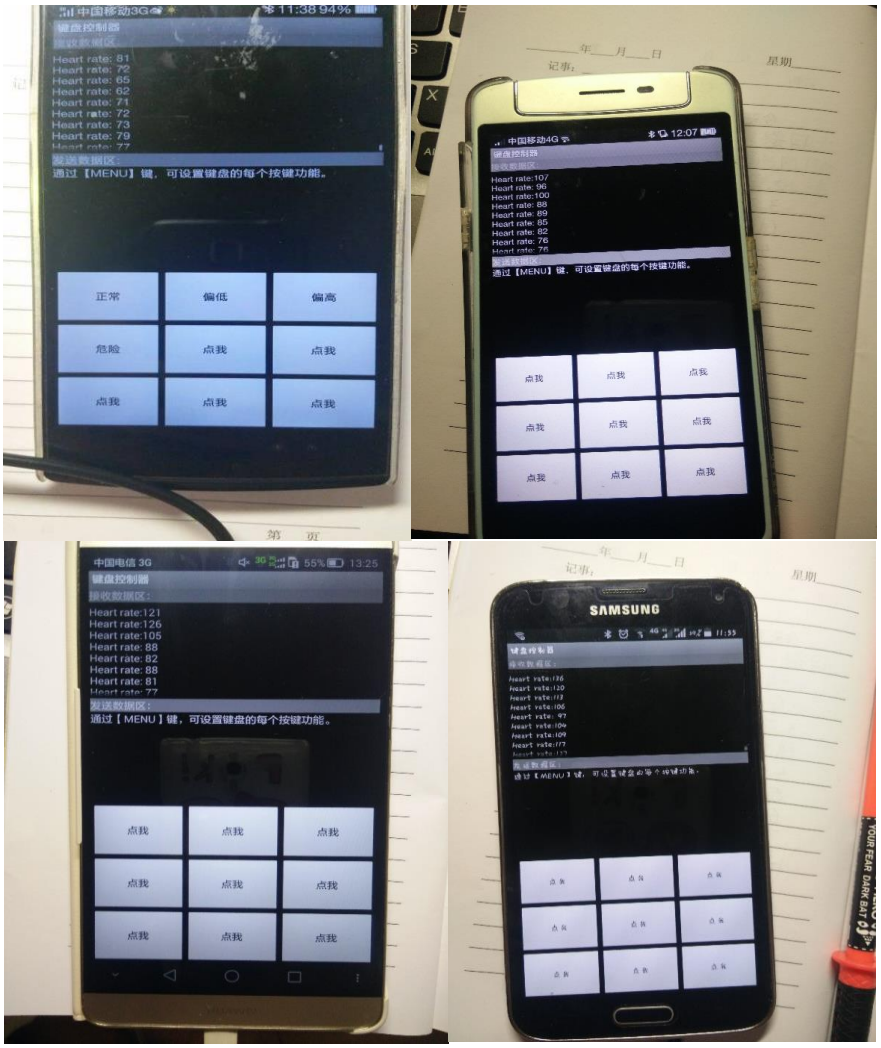

Figure. 8 Connection of various models of mobile phones

(2) Transmission distance test

Table 2 shows the system transmission distance test results for different distances from the mobile phone display and the LCD display:

Table 2 System Transmission Distance Test Results

NO.	Distance	Total times	Error count	Wrong rate
1	1m	50	0	0
2		100	0	0
3	5m	50	0	0
4		100	0	0
5	10m	50	0	0
6		100	0	0
7	15m	50	0	0
8		100	2	2%

(3) Repeatability test

Repeatability refers to multiple test results performed on the same instrument under the correct operation and the same external conditions. The same external conditions include the same operator and the same experimental environment. In this experiment, a sample was taken for detection. The results of the 10 data display during the measurement process are shown in Table 3. This repetitive measurement was performed within a short period of time when the sample was in a state of quietness and peace.

Table 3 Repeatability test

NO.	Heart rate meter display results	NO.	Heart rate meter display results
1	80	6	78
2	78	7	76
3	77	8	82
4	82	9	81
5	80	10	79

From the data in the above table, the average value of this test is 79.3, the overall standard deviation is 1.95, and the repeatability is 7.3%.

(4) Accuracy test

In the system accuracy test, the heart rate meter and the medical stethoscope are simultaneously measured and compared. On the one hand, a stethoscope is used to directly measure one minute's heartbeat and count, and on the other hand, the heart rate meter is tested at the finger and records the value displayed within one minute. The average is compared with the count value obtained with the stethoscope.

First, measure the data of five samples in a quiet state. The comparison results are shown in Table 4.

Table. 4 Comparison results of 5 samples

NO.	Heart rate meter average	Stethoscope test results	Error rate
1	77	79	2.5%
2	69	72	4.2%
3	76	79	3.8%
4	80	78	2.6%
5	82	80	2.5%

Second, measure the data of a sample in different states. The comparison results are shown in Table 5.

Table. 5 Comparison results of different states

NO.	Status	Heart rate meter average	Stethoscope test results	Error rate
1	Quiet	83	85	2.3%
2		80	84	4.7%
3		79	77	2.6%
4	After movement	145	150	3.3%
5		132	127	3.9%
6		130	135	3.7%

3. Conclusion

This paper studies the pulse heart rate detection based on the photovoltaic volume. From the test results, all the indicators have reached the expected design requirements. The comparison of the test results with the medical stethoscope has little fluctuation, and the human heart rate detector can monitor the human heart rate at any time and anywhere. And it has the characteristics of simple operation, low power consumption, portable, etc.

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