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Design and implementation of smart watch based on single chip microcomputer

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ABSTRACT:

With the development of smart wearable devices, smart watches have become one of its main development directions. It has been involved in people's social, medical, security and other fields, and has become a life assistant for many people. This project is a smart watch system based on MCU, mainly including MCU system, liquid crystal display, buttons, ambient temperature detection module, body temperature detection module, Wi-Fi module, voice recognition module, time timing module and heart rate module, which can be realized simply by voice control. page transitions to simplify operations. Accurate timing of all functions with four buttons. The liquid crystal can display the year, month, and date; it can measure temperature and humidity; it can measure human body temperature. The system has a total of four display pages, which can be interconnected with mobile phones through Wi-Fi to record data.

After the design of the whole process, the design of the smart watch is completed. In order to test the function of the system, a physical test is carried out, and the designed functions are tested one by one. The system function test meets the requirements of the original design, and the system works stably.

Keywords: smart watch, Wi-Fi, body temperature, voice, time

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I. INTRODUCTION

Today's society is in a transition period from the Internet era to the Internet of Things era. The era of the Internet of Things is coming. As wearable technologies continue to develop, they are not only changing social habits, but also improving daily life, health management and safety [1]. Judging from the current development situation, wearable devices such as smart watches, bracelets, and TWS headphones have good development prospects. The market size of products developing in these directions is likely to continue to maintain rapid development in the next few years. Usually, these devices tend to have more powerful chips, lower power consumption, and better peripheral sensors [2].

In the context of the rapid development of science and technology, the topic of wearable smart hardware has gradually become a popular trend. Smartwatch is actually one of the most important development directions of wearable smart hardware. Compared with other hardware, it is more It entered the user's field of vision early. For example, a multi-function watch based on the STM32F103C8T6 microcontroller can not only monitor the temperature of the human body [3], but also collect acceleration data through the acceleration sensor to accurately record the daily steps. Another example is other smart watches that can achieve real-time positioning and other functions.

The whole research content has several aspects. The first part needs to understand all the current related products and technologies, what functions the current products have, and clarify all the next work [4]. The second part enters the real design stage of the system, and designs the block diagram of each function of the system. The block diagram needs to indicate the signal connection between each function. Then in the third part, the hardware design is carried out on the basis of the second part. With the scheme, the device is clarified. As long as the design of the device is analyzed and the design method of the device is understood, the corresponding hardware design can be completed [5]. The main output of this part includes the circuit diagram of the designed hardware and the theoretical analysis of the relevant important parts. The fourth part is to design its software, study and study the relevant codes of each functional module and the arrangement and design of the flow chart. The fifth part requires the overall test of the first two parts, and the system design is basically completed through the two parts, but functional verification is required, and hardware verification is also required, and software verification is also required. fulfill the requirements [6]. After the test is successful, the entire project is completed, and finally a functional analysis is made.

II. OVERALL SYSTEM DESIGN

The system includes a single-chip microcomputer system, a liquid crystal display, a key, a temperature detection module, a body temperature detection module, a Wi-Fi module, a voice recognition module, and a time alarm clock module [7]. It can be controlled by voice, and all functions can be accurately timed with four buttons. The alarm clock function can be set, there is an annual calendar function, and the display screen can display the year, month, day, time and minutes. Temperature and humidity can be measured. It can measure human body temperature, and can be connected to the Internet with mobile phones to record data. The system is shown in Figure 1：

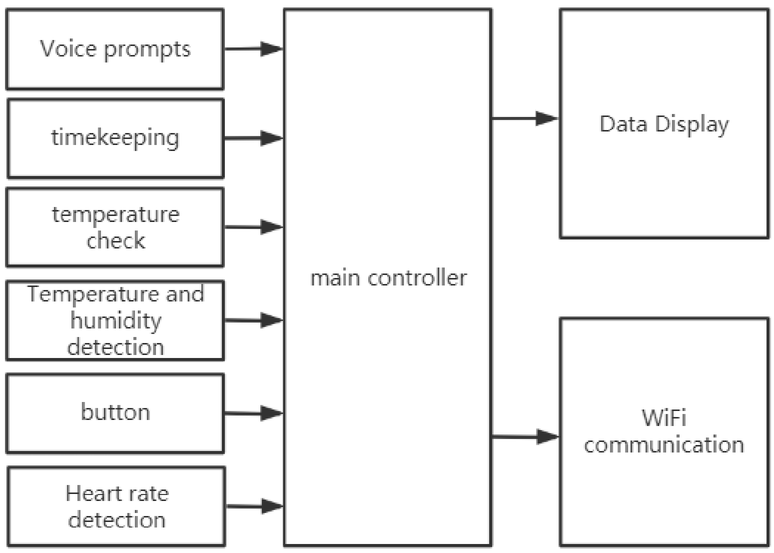

Fig.1 System Block Diagram

System functional requirements analysis:

(1) Wi-Fi communication design: ESP8266 is a dedicated Wi-Fi communication technology solution [8]. The module integrates all functions of Wi-Fi, and the commonly used TCP/IP protocol is also included. The module and the main control can communicate through the serial port. The module integrates the serial port data interaction scheme, which is convenient to connect with the main control, which can be applied to all main control devices on the market. As a common wireless data transmission technology solution, Wi-Fi communication has been widely used in many products.

(2) Body temperature detection design: The collection of body temperature is applied to DS18B20. The device has a wide temperature sensing range, which can reach -55 degrees Celsius to +125 degrees Celsius, which can meet the needs of product development and design [9].

(3) Temperature detection design: DHT11 is selected for the sensor of the ambient temperature and humidity acquisition part. This sensor is a sensor that can measure the temperature and humidity of the environment at the same time. In this sensor, the collected signal will be automatically calibrated, so the accuracy of the collected data is relatively high [10]. The digital processing technology and the temperature and humidity acquisition technology are integrated through the sensor to ensure that the collected data can be output stably and reliably.

(4) Heart rate detection design: The measurement of heart rate is realized by photoelectric sensor. Through the analysis of the detection principle, it is shown that the module has an infrared light emitting part and an infrared light receiving part, the infrared light emitting part is responsible for emitting infrared light, and the infrared light receiving part is responsible for receiving infrared light [11]. With the beating of the finger's heart rate, the blood will change, and the changing state will affect the penetration ability of infrared light, and then output the corresponding changing pulse.

(5) Voice recognition design: For the voice recognition control function of the desk lamp, choose the LD3320 voice recognition module [12]. This module integrates the LD3320 chip solution dedicated to speech recognition, which is more convenient for data processing in speech recognition. The built-in chip package of

the LD3320 module is small, low cost, and has a variety of packaging styles.
(6) Time timing design: DS1302 can complete the time timing work without occupying the resources of the microcontroller. The microcontroller only needs to read the output data of the DS1302 according to the control sequence required by the chip, and the output data includes the year, month, day, hour, minute, and second data. The chip automatically travels according to the set time, and the travel time is accurate [13].

III. HARDWARE CIRCUIT DESIGN

(1) Control circuit design
The controller selects STC15F2K60S2 to realize the control of all functions of the system and complete the control of each function of the system [14]. This series of single-chip microcomputers has four groups of IO port pins, and each IO port can be programmed to control. The main controller circuit diagram is shown in Figure 2：

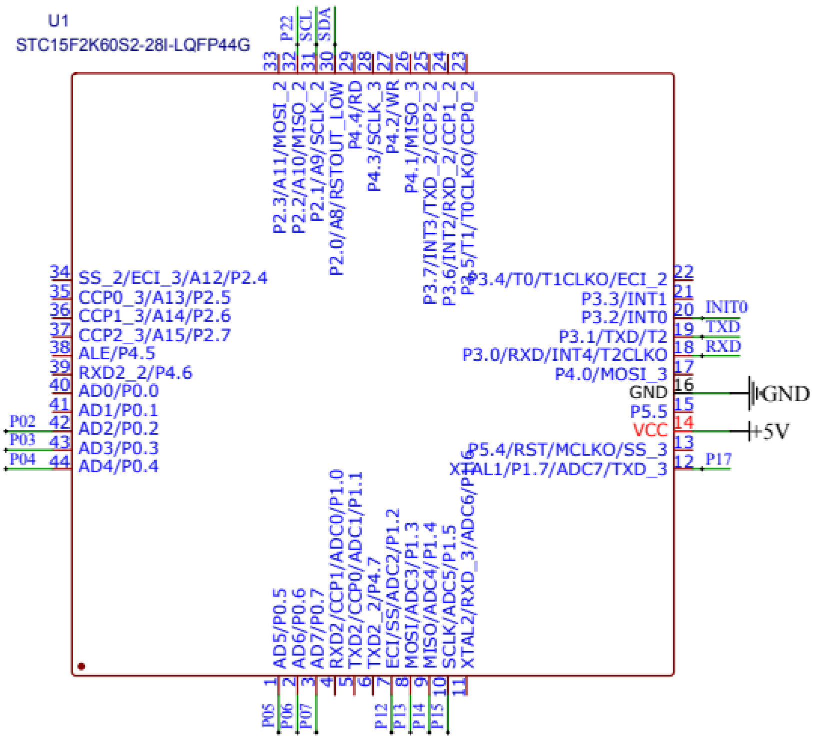

Fig. 2 Main controller circuit diagram

(2) Display circuit design

Data display select OLED. The control of the display is simple, and the main control controls the display content through the IIC. Therefore, only two signal lines are required for the main control. In the hardware circuit of the liquid crystal display function, it is necessary to understand the connection relationship of the circuit [15]. By analyzing the liquid crystal, there are a total of 4 outgoing signal interfaces, and the 5V power supply is selected here. The clock control interface is controlled by the master P2.1, the data control interface is controlled by the master P2.0, and the display circuit diagram is shown in Figure 3：

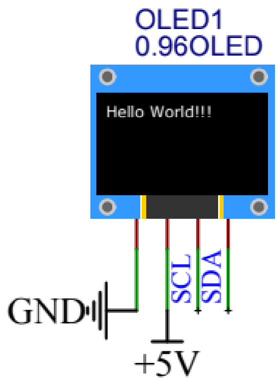

Fig. 3 Display circuit

(3) Wi-Fi communication circuit design

The connection between the Wi-Fi module and the single-chip microcomputer requires three signal lines, that is, the wire-speed connection of the serial port is completed, and the Wi-Fi data communication can be realized [16]. The Wi-Fi module leads out 8 signal lines, of which 8 pins are the power supply interface of the module. 2. Pin 3 is the control interface that comes with the Wi-Fi module; the Wi-Fi module itself can also be used as the main control to realize some control functions; Pin 4 is the data receiving pin led by the module; The RXD of 0 is connected together; the 1 pin is the power supply GND port of the module, and the Wi-Fi circuit diagram is shown in Figure 4：

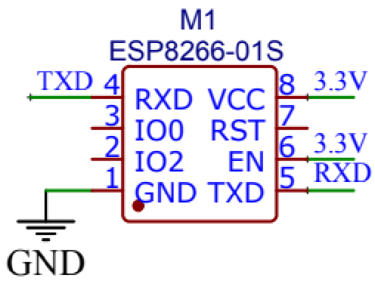

Fig. 4 Wi-Fi circuit diagram

(4) Body temperature detection circuit design

The body temperature DS18B20 does not need any device support in the hardware design, but in order to obtain the temperature signal, connect a resistor to the signal line, connect the other end of the resistor to the power supply, and design a pull-up resistor, which will make the system more reliable [17]. The data port DQ of the DS18B20 device communicates with P1.7 of the microcontroller, and the body temperature detection circuit diagram is shown in Figure 5：

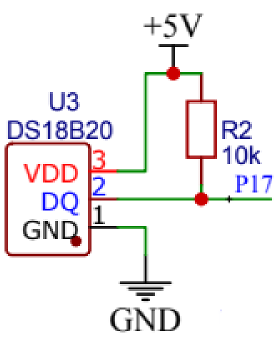

Fig. 5 Body temperature detection circuit diagram

(5) Temperature detection circuit design

The DHT11 sensor has a total of four interfaces, one of which is not used for human connection and connection, and has no function, so it is not reflected in the circuit diagram. The No. 1 port of the sensor is the power supply VCC port. The No. 2 interface is the data output port, which is connected to the P2.2 of the main control for data transmission [18]. The No. 3 port is the power supply GND port, and the temperature detection circuit diagram is shown in Figure 6：

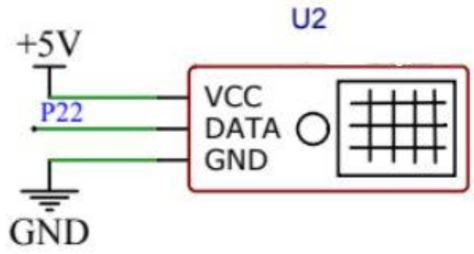

Fig. 6 Temperature detection circuit diagram

(6) Heart rate detection circuit

The measurement of heart rate is optoelectronic sensor. The signal directly output by the sensor is unstable and irregular. If the data is collected directly through the main control, the data will be inaccurate. In order to solve this unstable factor, after the sensor outputs the signal, the signal is processed and a comparator circuit is added. The signal output by the comparator will be more regular and stable. Only this ideal pulse signal can be measured by the main control [19]. The heart rate signal is collected by P3.2 of the main control chip. The heart rate detection circuit is shown in Figure 7：

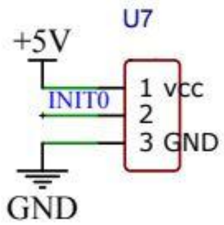

Fig. 7 Heart rate detection circuit

(7) Voice prompt circuit

Our speech recognition module is formed by assembling a microphone, a speech chip and a single-chip microcomputer. It is known that the selected model is the LD3320 chip, and the STM32 microcontroller is selected. The voice module leads out 5 interfaces. Among them, the No. 1 interface is powered by 5V. No. 2 interface is the power supply GND. The No. 3 interface is reset control, which is controlled by P0.4 of the microcontroller. No. 4 interface is data input control, which is controlled by P0.3 of the microcontroller. Interface No. 5 is data output control, which is controlled by P0.2 of the microcontroller. The circuit diagram of speech recognition is shown in Figure 8：

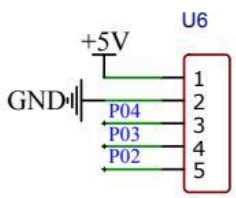

Fig.8 Speech recognition circuit

(8) Timing circuit

The power supply parameter of the system is 5V, and the voltage that the chip can supply is 3.3V to 5.5V, so the chip is also powered by 5V. The fifth port of the chip is the reset operation control signal input port, which is connected to P0.5 of the main control. The seventh port is the clock input port in the communication sequence of the single-chip control chip, which is connected to the P0.7 of the main control. The sixth port is the data bidirectional transmission port in the communication sequence of the single chip control chip is connected to P0.5 of the main control. The timing circuit diagram is shown in Figure 9:

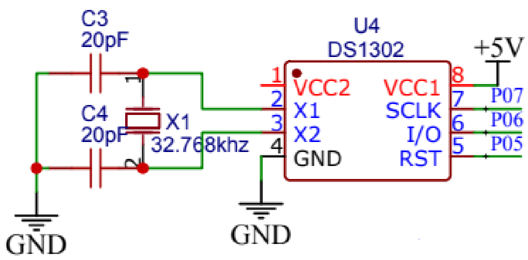

Fig.9 Timing circuit diagram

(9) Key circuit

The K1 button is used to realize simple page switching. There are four pages in total, and the page is changed every time the button is pressed [20]. The K2 and K3 buttons are used to adjust the hour and minute on the alarm page. In addition, the K4 is used to synchronize the network time, and the K2 The key signal is identified by the P1.2 interface, the K3 key is used to control the time data addition, and the key signal is identified by P1.3. Among them, the K4 key signal is identified by P1.4, and the key control circuit is shown in Figure 10:

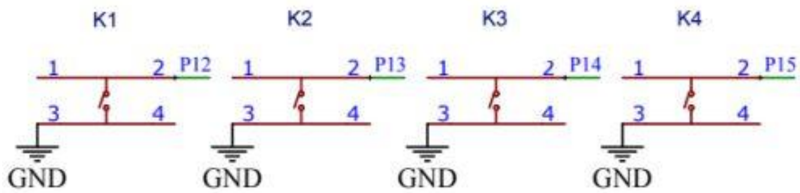

Fig.10 Button circuit diagram

IV. SYSTEM SOFTWARE DESIGN

(1) System main program design

The system first has liquid crystal display, buttons, temperature and humidity detection module, body temperature detection module, Wi-Fi module, voice recognition module, time timing module. The time and timing part is initialized, and it can be controlled by voice to realize page switching. In addition, four buttons can be used to realize accurate timing of all functions, an alarm clock function can be set, a calendar function can display the year, month, and date accurately, and temperature, humidity, etc. can be measured. Can measure human body temperature. The system uses the China Mobile open cloud platform OneNET for networking and mobile phone interconnection through the Wi-Fi module to record data. The main controller circuit diagram is shown in Figure 11：

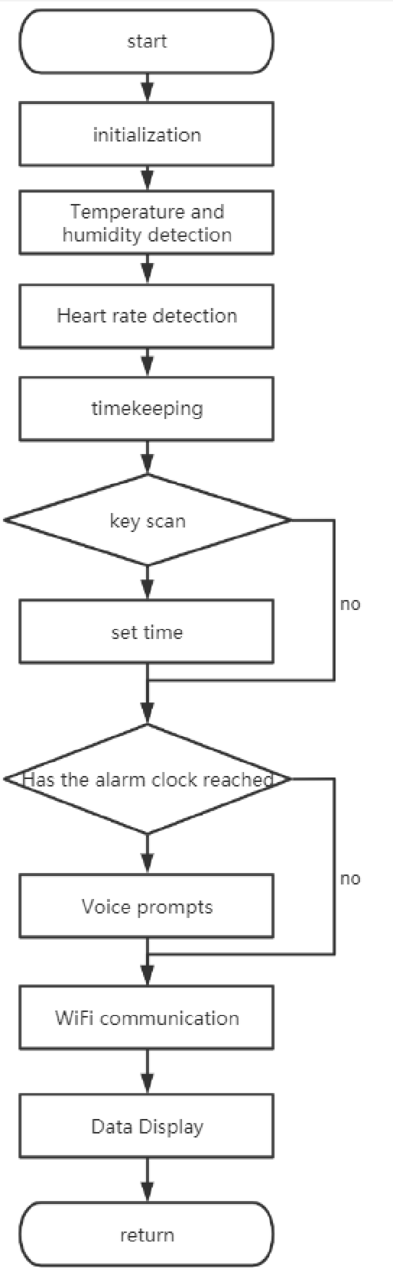

Fig. 11 System overall software design

(2) Display sub programming

The control of the main controller on the LCD needs to be installed according to the timing requirements of the LCD. It mainly controls the input of instructions and data to realize the content that the system needs to display. The single-chip microcomputer needs to make a busy identification and judgment on the display when controlling the display. Only when the display is not busy can it be controlled, and the relevant data and instructions can be input, and the display can be displayed according to the control data. The display circuit diagram is shown in the figure 12：

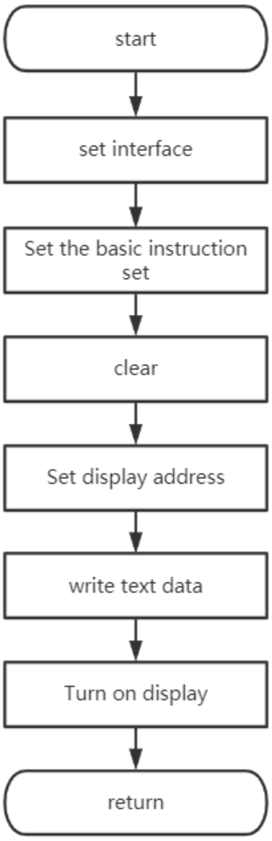

Fig. 12 Display software design

(3) Wi-Fi communication subprogram design

The single-chip microcomputer mainly inputs the corresponding data to the Wi-Fi module through the serial port to control the function of the module. To realize the serial port, it is necessary to determine the speed of the serial port data transmission, that is, the baud rate. After the timer is loaded with the initial count value, the timer is started, and the single-chip microcomputer can read the data by reading the register. The flow chart is shown in Figure 13：

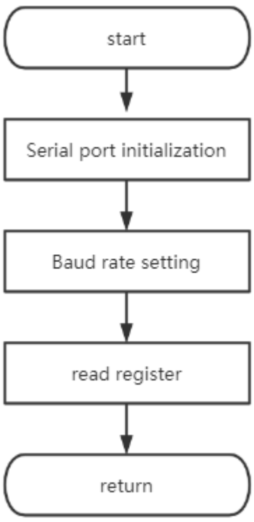

Fig. 13 Wi-Fi software design

(4) Body temperature detection subprogram design

The acquisition of temperature requires the single-chip microcomputer to operate the DS18B20. The system initializes the device and processes the data port at a high level for 48 microseconds. Then low-level processing is performed on the data port, and the time is maintained for 480 microseconds. Finally, it is necessary to perform high-level processing on the data port again to complete the initialization of the device. After completing the initialization work, the single-chip microcomputer waits for the temperature output signal of the device. When the single-chip microcomputer collects the output low level of the device, the single-chip microcomputer can control the device to output temperature data through commands. The temperature detection software design flow chart is shown in Figure 14：

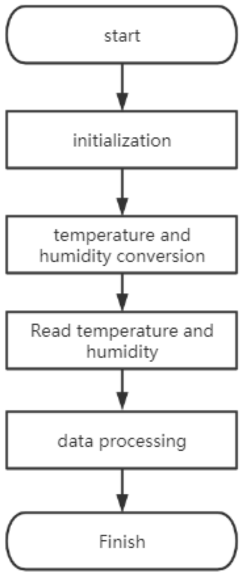

Fig. 14 Body temperature detection software design

(5) Temperature and humidity detection subprogram design

The software design of DHT11 temperature and humidity acquisition can be designed according to the required timing sequence. When temperature and humidity data collection is required, the master controller needs to first inform the sensor that it needs to obtain temperature and humidity data, and then start to output temperature and humidity data. The master controller is ready to receive temperature and humidity data. The design diagram of temperature and humidity detection software is shown in Figure 15：

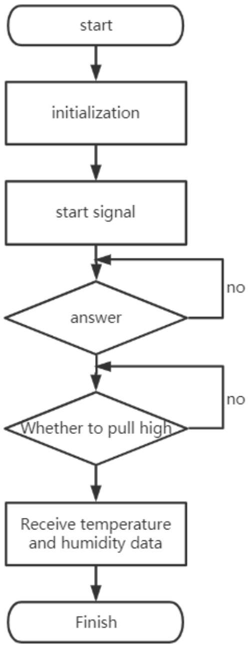

Fig. 15 Temperature and humidity detection software design

(6) Heart rate detection subprogram design

The mouth detection of heart rate is finally converted into the measurement of pulses, and the acquisition of heart rate data is completed by counting pulses. Once a pulse appears, it is a heart rate beat. The standard amount of heart rate data is the number of beats in one minute, so it is enough to judge the number of pulses in one minute. The interrupt processing function is applied in the design, and the interrupt is triggered when the pulse is input to ensure that each pulse will not be missed, which can effectively complete the acquisition of heart rate data. After the counting is completed, the final heart rate data is obtained with time technology.

(7) Voice Prompt Subprogram Design

The countdown software design of voice prompt is mainly through MOSI and MIOS. When performing data communication, the single-chip microcomputer must input a clock signal to the wireless chip, first enable and control the wireless chip, and input an effective enable signal. The data is shifted and transmitted according to the beat of the clock signal.

(8) Timing reminder program design

The acquisition of the time data by the single-chip microcomputer is to complete the control of the DS1302. The first step in the operation is to ensure that the signal of the reset port is at a low level. When the chip is working, it is necessary to set the RST to a high level, and when the data transmission is completed, it is required to set the SCLK to a low level. For direct data acquisition, if you want to get which part of the time data, you only need to let the microcontroller input the corresponding command to inform the chip. When the chip receives the command, it will output the corresponding accurate data to the microcontroller.

(9) Key Subprogram Design

The software design of the independent button is completely realized by the single-chip software scanning. In the process of completing the function of the independent button, the button must be debounced. The main reason is that when the button is pressed, this action is a mechanical action, and there will be friction if there is a mechanical structure. Therefore, when the button is pressed, the action inside the button will vibrate, so the signal output by the button also exists. shaking state. The key software design is shown in Figure 16：

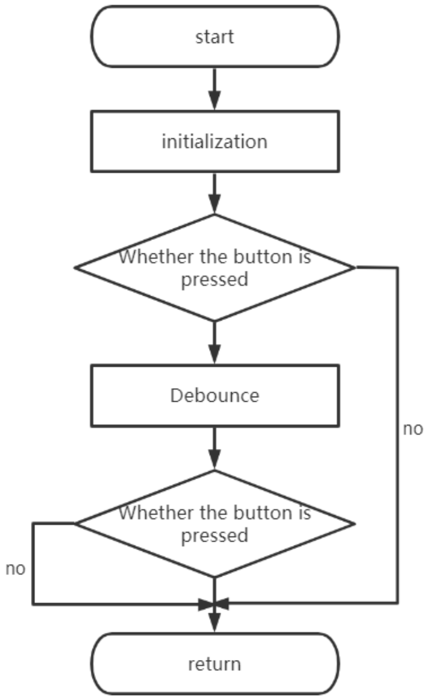

Fig. 16 Key software design

V. SYSTEM TESTING AND RESULTS

According to the system function design requirements, in this process, in addition to the completion of the principle development and design, it is also necessary to test the speech recognition system, to have a simple understanding and study of the Kaifeng cloud platform OneNET, and to continuously explore its data transmission. process of uploading, etc. The heart rate module also needs a simple study of its working principle, how it transmits the pulse as an electrical signal, and how to correctly display the real-time data on the display screen, as shown in Figure 17：

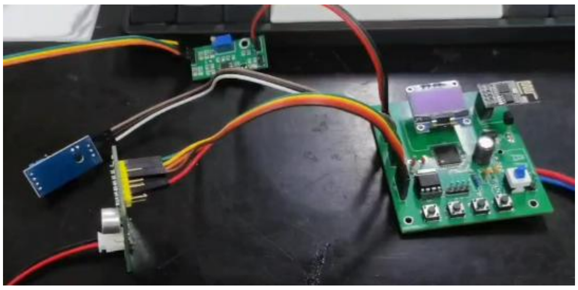

Fig.17 Physical map

Before powering on the speech recognition system, it must be ensured that the power supply of the speech recognition system will not be short-circuited. If a short circuit occurs, many devices on the system board of the speech recognition station may be irreversibly burned out, and the serious result will make the system board of the speech recognition station unusable. Use a multimeter to measure whether there is a short circuit in the system power supply. It must be ensured that there is no short circuit before the power is turned on. After the voice recognition system is powered on, the first step is to ensure that the power indicator is on normally. If the indicator light does not light up normally, the power supply must be cut off immediately. Need to look for the problem again until the power light turns on normally. Next, the speech recognition system can be tested. The system power-on test is shown in Figure 18：

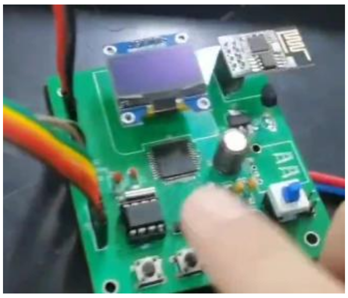

Fig. 13 System power-on test

VI. CONCLUSION

This design is implemented through Keil software and OneNET cloud platform. The software part is programmed in C language. The hardware part of the smart watch mainly includes OLED liquid crystal display time, human body temperature detection, ambient temperature detection and heart rate detection, and can also be controlled by voice. Implement page transitions. The design basically realizes the function control of each system, so as to facilitate life.

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