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Design of Wearable Human Health Data Monitoring Device

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Abstract: This article uses STC89C52 as the system's central control module, LCD1602 is used as the display module, receiving the digital signal from the single chip microcomputer, DS18B20 is used as the temperature sensor module of the system, receiving the external temperature signal to the single chip microcomputer, when the perceived temperature is too high and too low, the single chip transmits signals to an alarm circuit, taking Pulse Sensor as the heart rate sensor module of the system, The digital pulse signal after A/D conversion is transmitted to the single chip. When the collected heart rate is too fast and too slow, the single-chip microcomputer transmits the signal to the alarm circuit. With ADXL345 as the three-axis acceleration sensor module of the system, one acceleration component of the three-axis is measured, and the monitored value is transmitted to the single-chip microcomputer, which transmits it to LCD1602 for real-time display.

Keywords: Single chip, Heart rate sensor, Temperature sensor, Acceleration sensor

I. INTRODUCTION

The first foreign wearable physiological monitoring system[1][2] was developed by the American Georgia, mainly for military use, to monitor the casualties of soldiers on the battlefield. The initial wearable physiological monitoring system took fabric as the template, and took fiber and fabric as a whole[3]. Although its structure and appearance were simple, it had profound significance. Many wearable systems were designed based on this prototype in the later period, followed by the wearable human physiological signal detection system developed by an American company. British company Equivita had also introduced a dynamic vital sign monitoring system called Life Monitor[4]. In the late 1990s, the Georgia Institute of Engineering and Technology developed a smart shirt to monitor the physiological status and injury detection of American soldiers, as well as to detect gunshot wounds in combat[5]. At the same time, physiological parameters such as human ECG, body temperature and other sensors were monitored

Compared with foreign countries, the research on wearable devices in China started late, but there are many domestic researchers who have studied wearable monitoring devices. After continuous research, research results emerge in endlessly, and remarkable achievements have been made, such as the bioelectrical impedance based technology proposed by Jilin University, a method of collecting human respiratory signal by using fabric electrode is studied[6][7]; Li Suyi[8] used wavelet packet transform, lifting wavelet transform and static wavelet transform to suppress low-frequency noise effectively; The University of Electronic Science and technology of China and Nanchang Hangkong University have developed a textile based multi physiological signal monitoring device[9], for example, by combining textile technology with electronic technology, a variety of new textile materials are used to detect human physiological signals such as ECG, respiration and blood oxygen, so as to realize the miniaturization and portability of physiological signal detection, however, only three types of physiological signals are detected[10].

Compared with foreign wearable technology, there is still a certain distance in the research of wearable devices in China. Nowadays, there are still some deficiencies in wearable products suitable for families or communities in our country, and the existing human physiological parameters detection also has some shortcomings, such as poor user experience, low measurement accuracy in the mobile process, data cannot be displayed and stored in time, remote recording, and no warning mechanism when the data is abnormal.

II. THE DESIGN OF SYSTEM HARDWARE

2.1 Hardware design of main control unit

This design uses STC89C52 single-chip microcomputer, as shown in Fig. 1 below. The single-chip microcomputer has 40 pins, 4 groups of pins, 8 pins in each group. It is an 8-bit single-chip microcomputer, which conforms to the instruction set of MCS-51 single-chip microcomputer. The built-in memory of 16K size is convenient for users to burn programs repeatedly. At the same time, the data can be stored in it to avoid power loss. There are three timers and two external interrupts inside. The corresponding functions can be realized by simple configuration.

The minimum system is composed of reset circuit and crystal oscillator circuit. In the actual working environment, there are all kinds of interference or emergencies, so it is necessary to design a circuit, which can make the whole system start running again. This circuit is called reset circuit. Crystal oscillator circuit is a kind

of object that can generate stable frequency signal when it is powered on, and this characteristic is widely used in the reference clock of controller. Crystal oscillator circuit determines the actual running speed of single chip microcomputer. Crystal circuit generates corresponding clock signal to single chip microcomputer, and single chip microcomputer multiplies or divides the frequency of the signal, Then the signal is provided to the core of MCU as a reference.

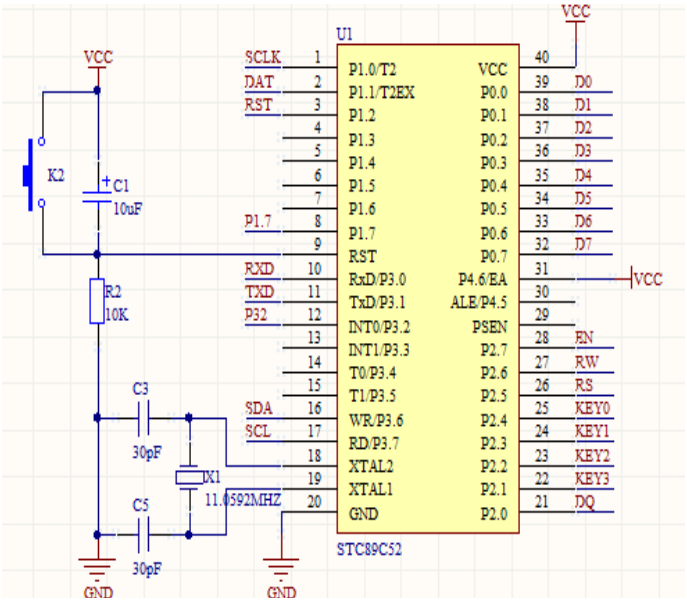

Fig. 1 STC89C52 single-chip microcomputer

2.2 Hardware design of three-axis acceleration sensor module

ADXL345 is a light, small and low energy consumption three-axis accelerometer. The digital output data adopts 16-bit binary complement format and can be accessed through I2C digital interface. ADXL345 is suitable for mobile devices and can measure static gravitational acceleration in tilt detection applications, as well as dynamic acceleration due to motion or collision. Its high resolution can measure the tilt angle change less than one degree.

Its circuit design diagram is shown in Fig. 2 below. P2 is GY-291ADXL345 integrated module, pin 1 is connected to power supply ground, pin 2 is connected to power supply 5V, the module adopts I2C digital interface, pin7 is SDA data pin, connected to P3.6 of MCU, pin 8 is SCL clock pin, connected to P3, 7 of MCU, other pins are not used.

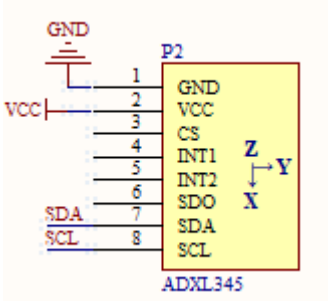

Fig. 2 ADXL345 circuit diagram

2.3 Hardware design of temperature sensor module

The design diagram of DS18B20 circuit is shown in Fig. 3 below. DS18B20 has only three effective pins, and the rest are empty pins. For the temperature sensor, in addition to the temperature detection element, it is converted into a digital signal to the main controller through the integrated digital IC. At the same time, it is equipped with a memory for storing data. It is also used for the temperature alarm function, which can write the corresponding alarm threshold to the chip through the main controller. When the detected temperature is greater than or less than the threshold, the temperature sensor can be used for temperature alarm and the corresponding signal will appear so that the controller can respond in time.

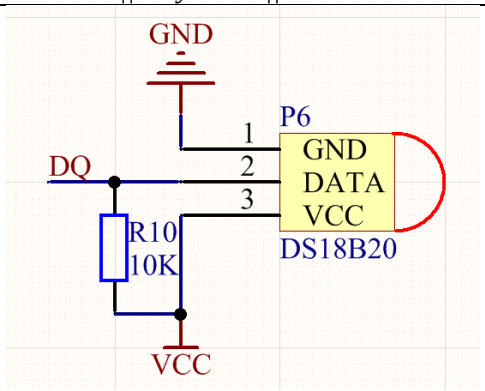

Fig. 3 DS18B20 circuit diagram

2.4 Hardware design of heart rate acquisition module

The design of heart rate measurement module has a variety of detection methods, mainly including photoelectric volumetric heart rate sensor and piezoresistive heart rate sensor. Now photoelectric detection technology is widely used in the medical field, mainly because the light energy can avoid electromagnetic interference to a certain extent and ensure strong overall insulation performance, In the process of patient detection, the relevant symptom information can be obtained without invading the patient's body. Using photoemission to extract the light information of fingertip heart rate can measure the heart rate. In the design of the heart rate measurement module, the fingertip transmission photoelectric sensor is mainly used, which can achieve photoelectric isolation and ensure certain interference to the analog circuit in the whole use process. The heart rate acquisition circuit diagram is shown in Fig. 4 below. The whole heart rate measurement sensor is mainly composed of light-emitting diodes and photodiodes. In the working process, the light source that can transmit the finger is emitted through the light-emitting diodes, and is absorbed by the finger blood tissue and then received by the photodiodes. Through the use of arterial blood, the physiological characteristics of periodic pulsation changes in blood circulation can be presented. Therefore, in the process of light source absorption, there will be periodic pulsating activities correspondingly. The whole heart rate measurement design uses photodiode to output the corresponding signal changes to reflect the pulsating situation of arterial blood.

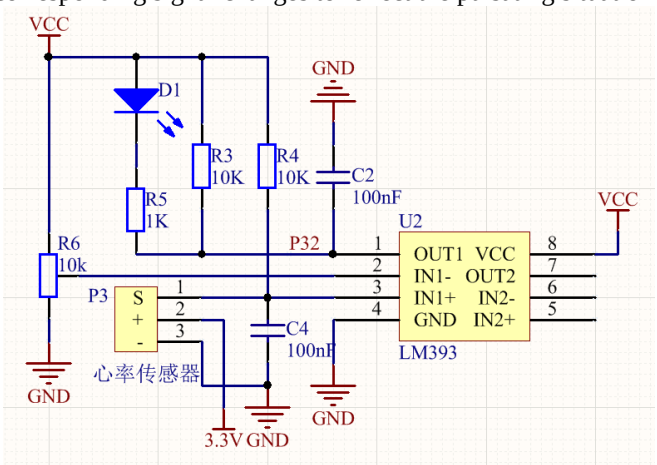

Fig. 4 Heart rate acquisition circuit

III. THE DESIGN OF SYSTEM SOFTWARE

3.1 The flow chart of system software

The flow chart of the overall software design is shown in Fig. 5 below. The system initialization includes the initialization of display screen, the initialization of acceleration sensor, the initialization of clock, serial port initialization configuration, EEPROM data reading, and all the main page is displayed as 0. Then enter the main program cycle, the main program cycle system meanly concludes the real temperature data acquisition, clock reading, heart rate signal measurement, using external interrupt and timer to achieve the capture of heart rate pulse signal, and finally calculate the actual heart rate value. When the measured heart rate value is higher or lower than the normal value, the alarm will give an alarm. DS18B20 is used to collect the human body temperature or the ambient temperature, and the temperature is displayed on the display screen. When the measured temperature value is higher or lower than the normal value, the alarm will give an alarm. The

acceleration sensor reads the data and realizes the algorithm step counting, and saves the steps to the EEPROM, When the time reaches 0:00 in the morning, it will automatically clear the number of steps and start counting again.

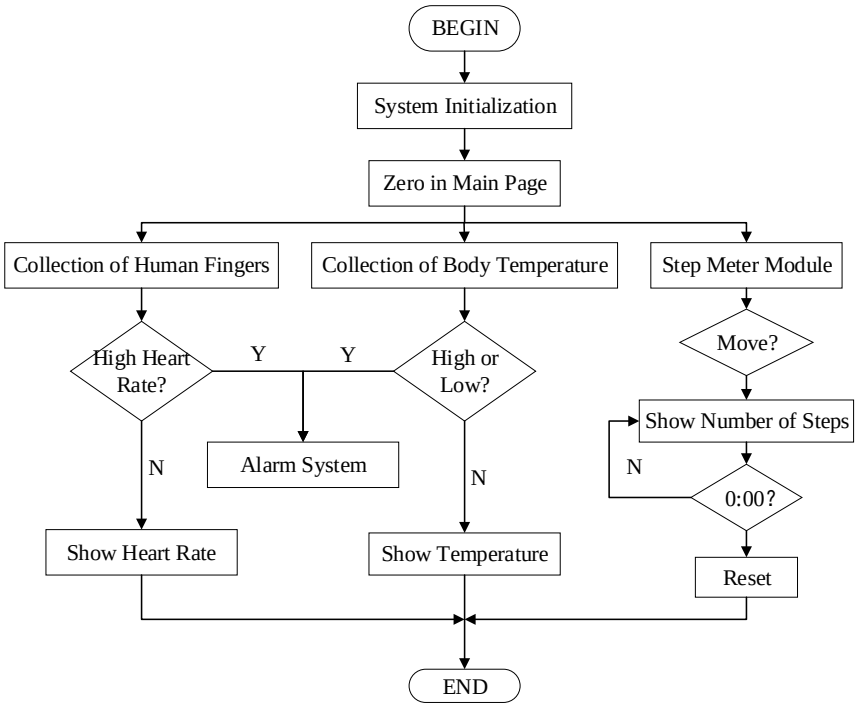

Fig. 5 Overall procedure flow chart

3.2 Software design of three axis acceleration sensor module

ADXL345 is an acceleration sensor, in this design, there is no need to measure the acceleration, but through some steps algorithm converts the acceleration of the process. In the process of human movement of walking, individual movement includes three components: forward, vertical and measurement. The step counting process is to judge the number of steps by reading the three-axis acceleration and judge the azimuth difference to implement the judgment. Firstly, the triaxial acceleration of A is read through the 2C interface, and whether the number of steps increases by 1 is judged by judging the angles of X, Y and Z axes.

At the same time, under the action of the real-time clock, it judges whether the time reaches 0:0. When the system works normally, the step number is updated once, and the data is stored once through the EEPR OM in STC89C52. The EEPROM with 2K bytes in STC89C52 MCU allocates two addresses to store the data.

3.3 Software design of temperature sensor module

This design uses DS18B20 temperature sensor to measure speed. DS18B20 temperature reading implementation process is: first, use the single chip microcomputer to send initialization signal to DS18B20 and wait for the response of DS18B20. If it responds, then start collecting data, start temperature conversion command, send reading matching command, read the corresponding temperature through the converted data, and finally display the temperature through LCD1602, If the detected temperature exceeds the threshold, it will give an alarm.

3.4 Software design of heart rate acquisition module

This design uses Pulse Sensor heart rate sensor to measure heart rate, because Pulse Sensor collects analog signal, so it must use the converter to convert the analog signal into digital signal to the MCU external interrupt pin, and then need timer and external interrupt configuration. The measurement process is as follows: firstly, the timer and interrupt of the single-chip microcomputer are initialized. The interrupt time is timed for 50ms, and then enter the cycle for real-time measurement. When the heart rate is detected, the timer is used to collect the time of five data points, and the interval between the previous heart rate and this heart rate is calculated. When the interval exceeds 1.25ms, it is considered to be an invalid heart rate, it is considered correct to trigger once less than 1.25ms, calculate the heart rate value, and finally display the temperature through the LCD1602. As shown in the Fig., if the heart rate measured exceeds the threshold, it will give an alarm.

IV. PHYSICAL MAP

The final physical map is shown in Fig. 6 below. After the welding work is completed, the solder joints of the whole system need to be tested to see whether there is missing welding's. If there is missing welding, repair welding should be carried out. At the same time, because there will be rosin and other substances in the welding process, so the circuit board will become dirty. Therefore, the circuit board needs to be cleaned again.

Fig. 6 Physical map

The commissioning diagram of the temperature module is shown in Fig.7 below. The main problem is that there is no response when measuring the temperature at the beginning. Later, I asked my classmates and finally found that the 10K pull-up resistance is not connected. I always thought there were some problems with the temperature module. After connecting the 10K pull-up resistance, it can work normally.

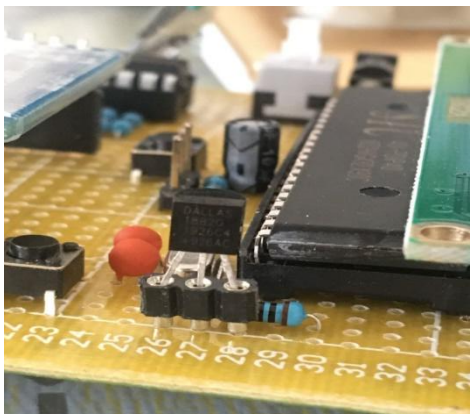

Fig. 7 Commissioning diagram of temperature module

V. CONCLUSION

This paper takes STC89C52 as the main control module of the system, LCD1602 as the display module of the system which receives the digital signal from the single chip microcomputer, and DS18B20 as the temperature sensor module of the system which receives the external temperature signal and transmits it to the single chip microcomputer. When the collected temperature is too high or too low, the single chip microcomputer transmits the signal to the alarm circuit.It takes Pulse Sensor as the heart rate sensor module of the system, and transmits the digital pulse signal after being concerted by A/D to the single chip microcomputer. When the collected heart rate is too fast or too slow, the single chip microcomputer transmits the signal to the alarm circuit, and takes ADXL345 as the three-axis acceleration sensor module of the system to measure an acceleration component of the three-axis, The monitored value is transmitted to the single chip microcomputer, which is transmitted to the LCD1602 for real-time display. After the final test, the design scheme has the advantages of simple and convenient operation. It can better detect the steps of human heart rate and body temperature, be widely used by most people, and successfully achieve the required functions.

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