The Design of an Intelligent Interaction System for Healthcare Monitoring

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Abstract. The design is a set of intelligent healthcare software and hardware system which can monitor physiological parameters like body temperature and heart rate in real time. The single-chip as a carrier, DS18B20 as a temperature sensor to collect body temperature, and ST188 infrared tube as a heart rate sensor to collect heart rate data were used in the system. To meet better interactive experience, this paper presents a self-developed medical website for reference, users can evaluate their health status more accurately and choose medical services reasonably. The GSM module could send related signals to the user's smartphone which included temperature and heart rate data and an additional self-examination website to check the physical condition. The system has been tested, the function runs normally, the performance is stable.

Introduction

Nowadays, there’s no doubting the fact that stress leads to illness and disease with a busy life, which made people have no time to go to the hospital for physical examination, which laid a huge risk for malignant diseases. The intelligent health monitoring system has evolved rapidly to become an alternative to traditional healthcare solution. In recent years, researchers have developed a variety of health monitoring systems to assist citizens [1-2]. Numerous studies on the health monitoring system are based on the sensing systems, communication technologies, and data processing. The sensors are responsible for data acquisition [3-4]. The communication solution includes gateways and several short-range wireless transmission technologies which are most popular such as ZigBee, Bluetooth, WiFi, and recently Bluetooth Low Energy [5]. This design focused on simplifying the structure and simple operation interface. Some commonly detectable physiological signals such as temperature and heart rate were collected, filtered and amplified, then sent to the control center for the analysis and feedback to the user in the system.

The paper is organized as follows: Section1 describes the solution and architecture of the intelligent interactive system for healthcare monitoring. Section 2 presents the hardware design of system. Section 3 presents the software design of the system. System test and results are presented in Section 4, and finally, Section 5 describes conclusion and future scope.

Solution of the Intelligent Interactive System for Healthcare Monitoring

In this design, the low-cost single chip was used as a carrier. The heart rate and temperature information were collected by the optical and temperature sensors and proceeded through the filtering and amplifying circuit. The GSM module sent related signals to the user’s smartphone which included temperature and heart rate data and an additional self-examination website to check the physical condition. This interactive interface can significantly improve user experience. The block diagram of the system is shown in Figure 1.
Hardware Design for Healthcare Monitoring and Interactive System

In this system, the temperature sensor DS18B20 was used, ST188 Infrared tube pair as the heart rate transmitter. A typical RC filtering circuit and LM358 dual-operation amplifier were designed. The SIM800C module was selected as the sender so that the user could use the system normally without relying on the GPRS and WI-FI signals. The specific circuit design is as follows:

Heart Rate-collecting Circuit

ST188 is a photoelectric sensor. According to its electrical characteristics, the static current is 20mA. If the nominal resistance R is equal to 200, the current will be less than 20mA, which does not affect the testing result. The resistance of the CJE terminal is relatively flexible. The resistor is used to output high or low levels, which is usually a connected sliding rheostat to adjust the threshold voltage. The ST188 connection method is shown in Figure 2.

Data Sending Circuit

The SIM800C can be applied to various portable products because of its small size. It contains TTL, level interface, and can implement such functions as a phone call, SMS, GPRS data transmission, TTS, Bluetooth (not supported by some software versions), etc. The SIM800C connection circuit is shown in figure 3.
Software Design for Healthcare Monitoring and Interactive System

The temperature data collected by the sensor is directly displayed on the LCD screen. The collected heart rate data could be filtered, amplified and quantified before being transmitted to the main control chip, which makes a judgment on whether the heart rate is abnormal or not. If the heart rate is abnormal, the sound and light alarm circuit responds, and the main control chip controls the SIM800C to send the corresponding information to the user's phone; If not, the heart rate data is displayed. Figure 4 shows the working flow.

Figure 4. Main control flow.

In actual operation, the user needs to input “PHONE SMS+Mobile Phone Number” to bind, otherwise the GSM cannot find the trusted party and the data transmission cannot be completed. The corresponding key program of submodule is as follows:

```c
void GSM_Init2()
{
    unsigned char G_Tab[20]=0;
    if(Quest_flag==1)
    {
        switch(GSM_Num)
        {
            case 0: UartData_Byte("AT\r\n"); break;
            case 1: UartData_Byte("ATE1\r\n"); break;
            case 2: UartData_Byte("AT+CNMI=3,2,2,0,1\r\n"); break;
            case 3: UartData_Byte("AT+CMGF=1\r\n"); break;
            case 4: UartData_Byte("AT+COPS?\r\n"); break;
            case 5: Quest_flag=0; GSM_Num=0; break;
        }
        GSM_Send_Time=10;
    }else
    {
        GSM_Send_Time=40;
        if(GSM_Send==1)
        {
            if(GSM_Send_Num==0)
        }
    }
```

System Testing and Results

a. Initialization

In the case of no power supply, a SIM card was inserted. The indicator of the SIM800C module flashed about 3 seconds which indicated successful initialization. Next, AT command was sent to bind mobile PHONE number, and the user can enter "PHONE SMS: PHONE number", waiting for a reply.

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b. Temperature test
The DS18B20 was sterilized with alcohol and placed in the air. The displayed indoor temperature was 25.9 degrees, as shown in Figure 5. The user held it in the palm and 35 degrees was read, as shown in Figure 6.

![Figure 5. Indoor temperature test.](image1) ![Figure 6. Body temperature test.](image2)

c. Heart rate test
The heart rate thresholds were set by keys 1, 2, and 3. Key 1 was the part that was the index finger pressed, left to right, key 2 and key 3 respectively. Key 1 was pressed to set the minimum heart rate threshold, key 2 was pressed to increase the value, and pressing key 3 to reduce the threshold successively. The minimum heart rate threshold was set to 60 times/min, and the maximum one was 100 times/min (from fuzzy to clear respectively), as shown in figure 7(a,b,c). Finally, key 1 was pressed to return to the measurement interface.

![Figure 7. Heart rate threshold setting.](image3)

The heart rate test was started by pressing key 3. The normal heart rate was indicated without an alarm which was within 60-100 times/min, meanwhile, the indoor temperature was displayed, as shown in figure 8. If the heart rate value was more than 100 times/min or less than 60 times/min, a message will be sent, accompanied by the alarms, as shown in Fig. 9 and Fig. 10 respectively.

![Figure 8. Normal heart rate value.](image4) ![Figure 9. Lower heart rate value.](image5) ![Figure 10. Higher heart rate value.](image6)
Information interaction

The relative information would be sent to the phone according to test results. For example, if the heart rate value is abnormal, the user could receive the results, suggestion and medical website to refer, as shown in figure 11. The user could visit various medical links guided by the page, even making an appointment, as shown in figure 12.

Summary

An intelligent interaction system for healthcare monitoring was studied in this paper. The DS18B20 was used as a temperature data collector, ST188 to collect heart rate data. The LM358 was used as a signal amplifier circuit, and a traditional RC filtering was adopted. The collected physiological signals were filtered and amplified and then sent to the control center for analysis and feedback to the user, who could visit the medical website to obtain more relevant information. The design has the advantages of convenience, low cost, accurate measurement, and better interaction. Base on blood oxygen, blood pressure and step counting measuring methods, additional functions can be expanded in the future.

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