Human Parameter Acquisition System Design Based on Three-axis Gyroscope

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Abstract: With the development of Internet of Things applications, it is possible to capture human parameters in real time using sensors. The collection of human body data is widely used in the measurement of sports energy consumption and the collection of health information. The system designs a three-axis gyroscope-based human parameter system, which is dominated by STM32 and is controlled by MPU6050 and MAX30102. Sensors collect information such as body movement parameters, body temperature, heart rate, blood oxygen, etc. The collected data is also uploaded to the server and visualized by the server. With the improvement of people's living standards, more and more people pay attention to their own health and family, whether through exercise health management, or usually monitor their own physical condition, especially the health status of the elderly population, make the real-time collection of human parameters become very important.

1. The overall design of the system

The system uses THE STM32F103C8T6 chip as the control core, using the MPU6050 sensor chip to collect six-axis acceleration information and body temperature information, select MAX30102 sensor chip captures heart rate, blood oxygen information, and uses the collected information via the ESP8266 module . The socket communication standard is uploaded to the server and visualized by the server. Human Parameter Acquisition shown in Figure 1.

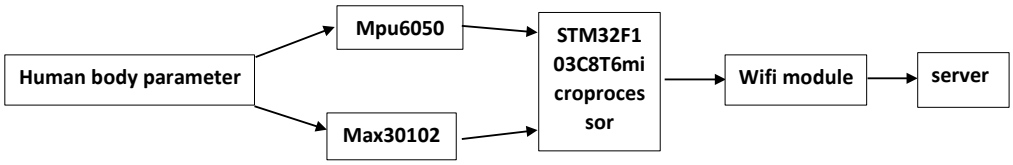

Figure 1. System hardware structure diagram

The software programming of the system mainly achieves the following functions:
(1) Three-axis gyroscope MPU6050 sensor reads information and temperature;
(2) MAX30102 sensor chip reads heart rate, blood oxygen information;
(3)ESP8266 data uploader.
The software structure of the human parameter acquisition system is shown in Figure 2.

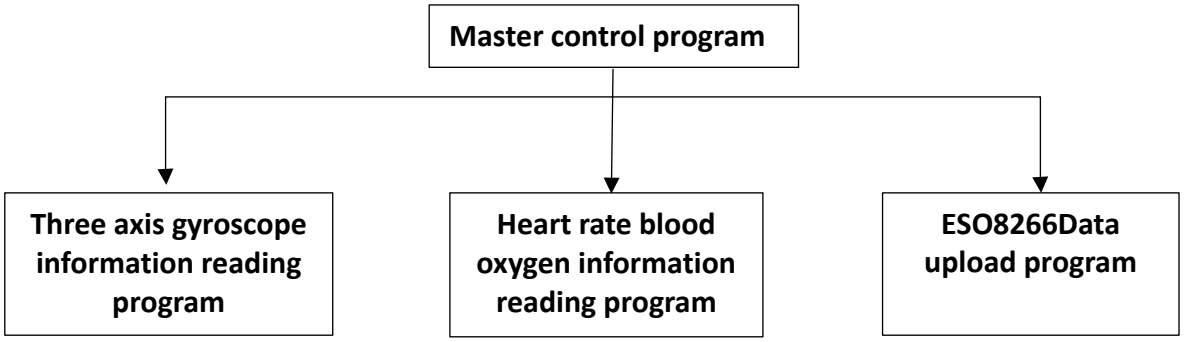

Figure 2. System Software Structure

2. Hardware circuit design

Based on the three-axis gyroscope of human parameter acquisition system, the main hardware circuits include the microcontroller minimum system, three-axis gyroscope sensor circuit, MAX30102 sensor circuit.

2.1. Microcontroller Minimum System

The system uses the STM32F103C8T6 as the control core, and the chip is a 32-bit microcontroller based on the ARM Cortex-M core STM32 family with a rich peripheral configuration. The minimum system circuit diagram is shown in Figure 3.

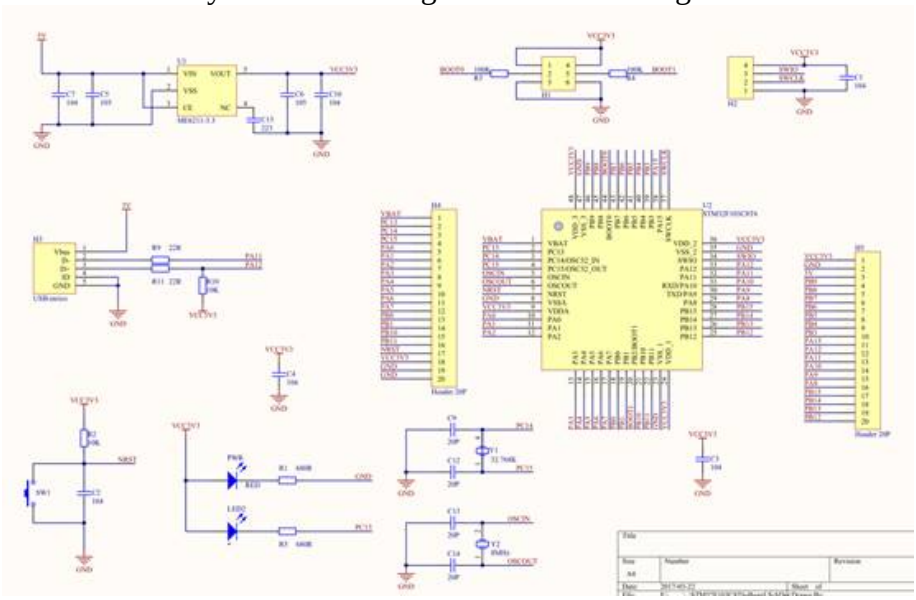

Figure 3. Minimum system circuit diagram

2.2. Three-axis gyroscope sensor circuit

THE ATK-MPU6050 is a high-performance three-axis acceleration and three-axis gyroscope six-axis sensor module introduced by ALIENTEK The MPU6050 is the core, with three-axis gyroscopes and three-axis accelerometers integrated inside the chip, and the use of its own digital motion processor hardware acceleration engine via the IIC interface, the data after the post-post post-attitude solution is realized by exporting the attitude to the application side. The module is small, comes with its own DMP comes with its own temperature sensor, supports IIC machine address settings and interrupts. The system collects motion parameters and temperature information, as shown in the Figure 4.

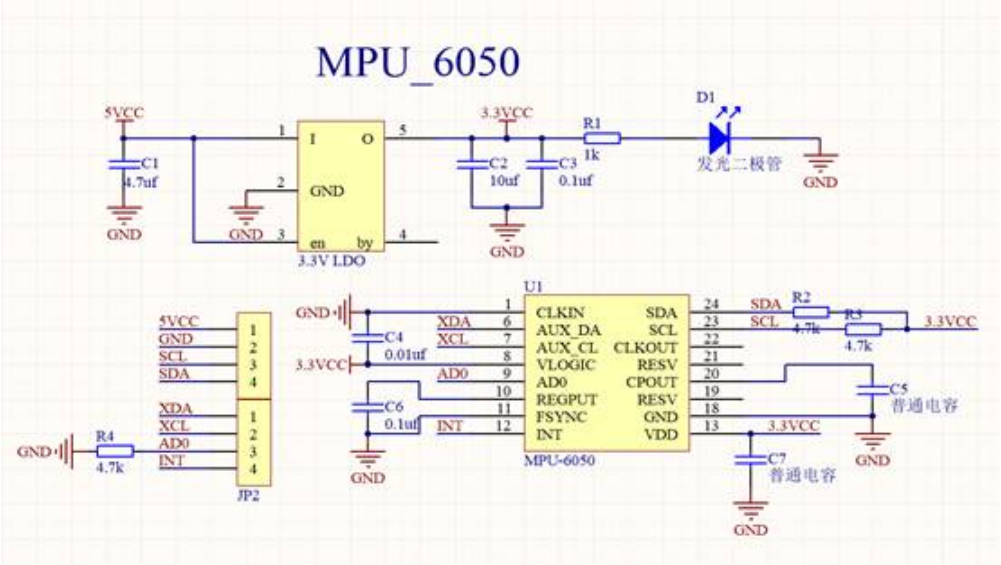

Figure 4. MPU6050 Sensor Circuit

2.3. MAX30102 Sensor Circuit

The MAX30102 is a highly sensitive blood oxygen and heart rate biosensor, including internal LEDs, photoelectric detectors, optics, and communication through a standard IIC interface. Mainly used in wearable devices and bodybuilding aids. The chip can be switched through the software switch module, the current is close to 0, so that the power supply always maintain the power state. The principle is:

(1) Photo-dissolved product method: the use of human tissue in the blood vessels when the resulting different light transmission rate for pulse and oxygen saturation measurement;

(2) Light source: oxygenated hemoglobin(HbO2)in the pulsating blood- and hemoglobin (Hb) selective light-emitting diodes of specific wavelengths;

(3) The transmission rate is converted into an electrical signal: the dynamic pulse of the permeable light changes, at which point the photoelectric transformation receives the reflected light from human tissue, transforms it into an electrical signal and enlarges it.

$$SaO_2 = \frac{C_{HbO_2}}{C_{HbO_2}+C_{Hb}} \times 100\% \quad (1)$$

The MAX30102 sensor circuit diagram is shown in Figure 5.

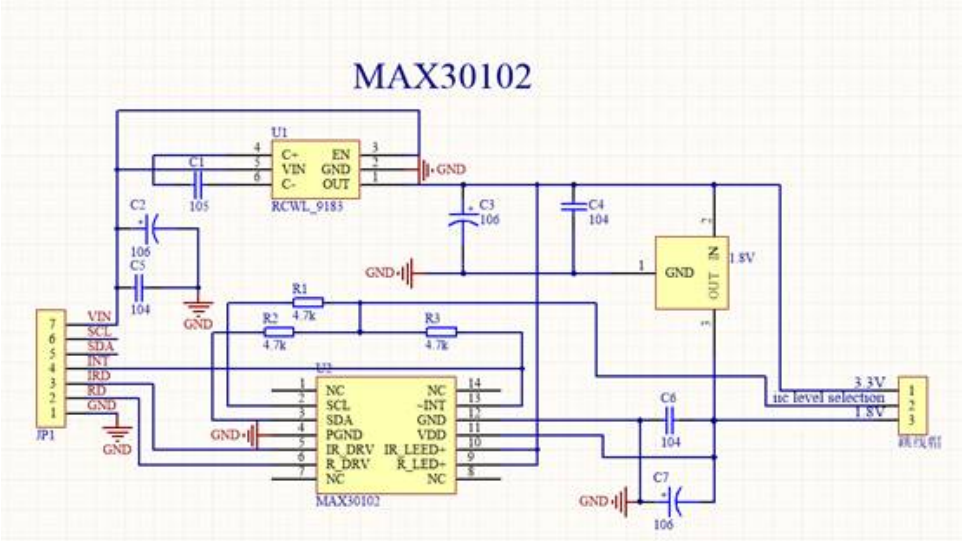

Figure 5. MAX30102 Sensor Circuit

The overall hardware circuit diagram of the system is shown in Figure 6.

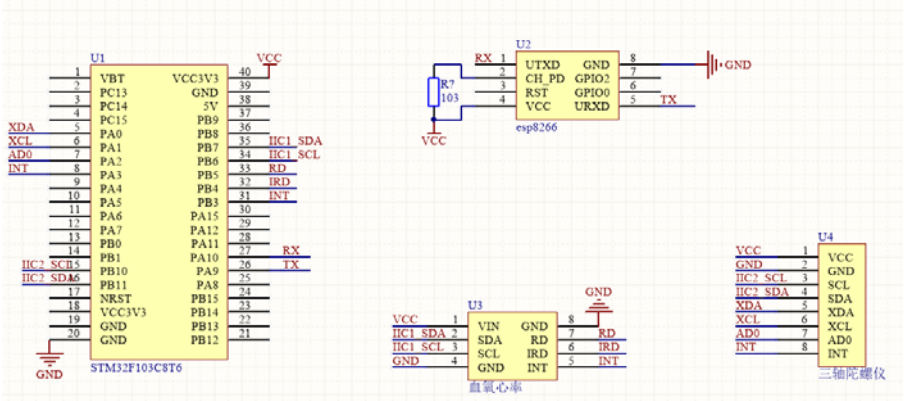

Figure 6. System overall hardware circuit diagram

3. System software design

The system is programmed in C language, mainly including the three-axis gyroscope information reader, heart rate blood oxygen information reader and ESP8266 data uploader.

3.1. Three-axis gyroscope information reader

The main functions of the three-axis gyroscope are the output acceleration value and temperature, as shown in Figure 7.

```
void READ_MPU6050_GYRO(void)
{

    BUF[0]=Single_Read(GYRO_ADDRESS,GYRO_XOUT_L);
    BUF[1]=Single_Read(GYRO_ADDRESS,GYRO_XOUT_H);
    T_X= (BUF[1]<<8)|BUF[0];
    T_X/=16.4;

    BUF[2]=Single_Read(GYRO_ADDRESS,GYRO_YOUT_L);
    BUF[3]=Single_Read(GYRO_ADDRESS,GYRO_YOUT_H);
    T_Y= (BUF[3]<<8)|BUF[2];
    T_Y/=16.4;
    BUF[4]=Single_Read(GYRO_ADDRESS,GYRO_ZOUT_L);
    BUF[5]=Single_Read(GYRO_ADDRESS,GYRO_ZOUT_H);
    T_Z= (BUF[5]<<8)|BUF[4];
    T_Z/=16.4;


    BUF[6]=Single_Read(GYRO_ADDRESS,TEMP_OUT_L);
    BUF[7]=Single_Read(GYRO_ADDRESS,TEMP_OUT_H);
    T_T=(BUF[7]<<8)|BUF[6];
    T_T = 35+ ((double) (T_T + 13200)) / 280;
}
```

Figure 7. Three-axis gyroscope information reader

3.2. Heart rate blood oxygen information reader

The main function of the MAX30102 sensor is to collect heart rate and blood oxygen data, as shown in Figure 8.

```
  IIC_Send_Byte(max30102_WR_address | I2C_RD);


  if (IIC_Wait_Ack() != 0)
  {
    goto cmd_fail;
  }


  Data[0] = IIC_Read_Byte(1);
  Data[1] = IIC_Read_Byte(1);
  Data[2] = IIC_Read_Byte(1);
  Data[3] = IIC_Read_Byte(1);
  Data[4] = IIC_Read_Byte(1);
  Data[5] = IIC_Read_Byte(0);


  IIC_Stop();

cmd_fail:

  IIC_Stop();
```

Figure 8. Heart rate blood oxygen information reader

4. Conclusion

In this paper, a 3D gyroscope-based human parameter acquisition system is designed, with the STM32F103C8T6 microprocessor as the control core, through the MPU6050 sensor And THE MAX30102 sensor information reading, detection of human body motion parameters, body temperature, heart rate and blood oxygen information, and then through the analysis of these data, to obtain the human body's movement and health status, to achieve real-time health monitoring purposes. Has a high practical value.

Acknowledgement

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References

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