

Health Monitoring System for Medical Staff based on STM32 MCU

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Abstract

With the development of society, the work health monitoring of medical staff has gradually become an important issue. Long hours of continuous work, high intensity of physical and psychological pressure bring physical health problems for medical staff. In view of this phenomenon, a new type of health monitoring equipment for medical staff is developed, aiming at providing comprehensive health monitoring services. The medical monitoring system uses STM32 single chip microcomputer as the core controller, which has the functions of heart rate monitoring, step statistics, temperature measurement, alarm reminder, SMS reminder and so on. Worn on places such as a healthcare worker's wrist, the device can monitor their heart rate changes in real time and record their steps. This provides health care workers with convenient health data to help them understand their physical condition. The device has the advantages of simple operation, complete functions and beautiful appearance design. The intelligent device can provide comprehensive and accurate health monitoring services for medical personnel, and has a good market prospect.

Keywords

Medical Monitoring; STM32; Heart Rate Monitoring; Wireless Communication.

1. Introduction

Ensuring the health of medical staff is the foundation of the development of medical career, and the health of medical staff should always be placed in an important position. Physical and mental health problems often arise as a result of the long and intense hours of work. Therefore, it is necessary to develop a new type of medical personnel health detection equipment to provide all-round health monitoring services.

There is no separate health monitoring equipment for medical personnel on the market for the time being, and the problem of some derivative products is that the function is not comprehensive enough, there is no backup power supply in emergency situations, and insufficient power will lead to the normal operation of the equipment. In addition, under the high-intensity daily work, the physical condition of medical staff will have some abnormalities, such as irregular heart rate and abnormal body temperature. They will ignore the importance of their own health because of busy, which may eventually lead to serious consequences. In response to these problems, intelligent medical personnel health detection equipment must improve the accuracy of heart rate, body temperature measurement results and reminders, while supporting SMS reminder and alarm functions.

In summary, the design of the project considers special consideration the actual needs of medical personnel, mainly in terms of intelligent heart rate monitoring, SMS reminders and alarms that do not rely on any manufacturers, so as to better serve medical personnel and maintain their health.

2. Hardware Design of Medical Monitoring System

Considering that the health status of medical personnel needs timely monitoring and protection, the health detection equipment of medical personnel should have a number of practical functions. In view of the characteristics of medical personnel working for a long time, the equipment should be able to accurately monitor the heart rate, body temperature and other indicators, and can promptly alert abnormal situations. The functions of the medical monitoring system should include heart rate monitoring, temperature measurement, liquid crystal display, SIM card communication, etc. In addition, in order to facilitate the daily use of medical staff, the equipment should also have timely reminder, wireless communication, portable storage, reliable power supply and other functions.

The hardware platform of the system includes the core control chip STM32F103C8T6 based on the ARM system, pulse rate sensor module, CJMMCU-MMA9555L step counting module, communication module, OLED display module, and OLED control module. The STM32F103ZET6 chip is used as the control center, the Real-time Clock (RTC) inside the chip is used to provide the current time and date, the current date can be viewed through OLED, and the normal heart rate and body temperature range of the wearers of the device are initialized. When the normal range is repeatedly exceeded, the device will alarm and send a short message reminder to the main control room or personal mobile phone. At the same time, the step counting device will also record the work intensity of the medical staff on the day, and then monitor the health of the medical staff. This design adopts the method of SMS transmission to ensure the stability and convenience of the system communication, so that the data transmission is more efficient and reliable [1]. The system structure is shown in Figure 1:

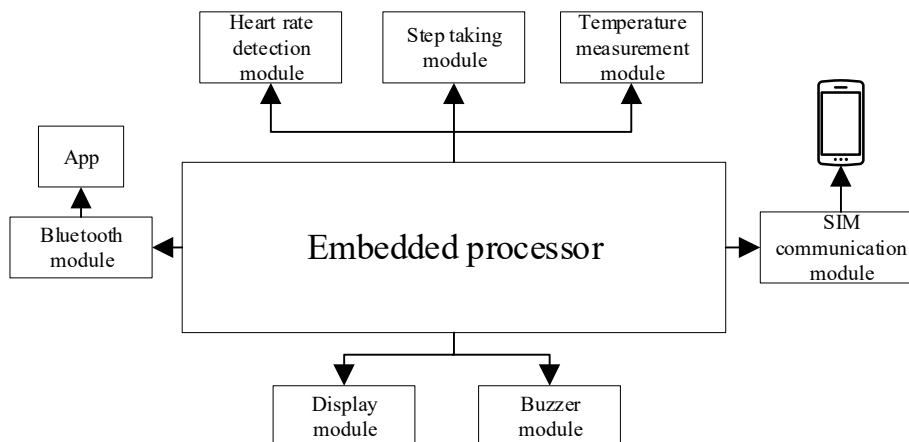


Figure 1. Structure diagram of system

2.1. MCU Main Control Module

In this system, we use the 32-bit Cortex-M3 core ARM microprocessor produced by ST - STM32F103C8T6. This type of chip has a range of powerful functions and features, making it ideal for application in iot monitoring devices. The STM32F103C8T6 chip has a built-in 64K byte Flash memory and 48 pins, including 38 which can be used as input/output (I/O) ports. In addition, the chip is capable of operating over a wide range of ambient temperatures, from -40 degrees Celsius to 85 degrees Celsius, and supports operating voltages from 2V to 3.6V.

The operating voltage is set to 3.3V. In order to generate high and low speed external clock signals, we chose 8MHz and 32.768KHz crystal vibrators. At the same time, the system adopts the key reset mode to ensure that the system can be reset when needed. The interface circuit of CPU module is shown in Figure 2:

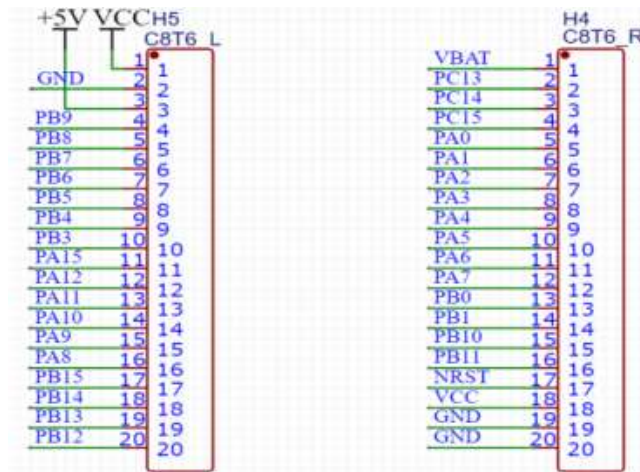


Figure 2. CPU module

2.2. Pulse Heart Rate Sensor Module

The pulse heart rate sensor module is a device used to measure the human pulse and heart rate. It typically uses optoelectronic plethysmography (PPG) technology to monitor changes in heart rate and pulse by sensing blood flow within blood vessels. The module has a high degree of integration and stability, built-in a special algorithm chip, the module can monitor the change of the value in real time and calculate and output the value of heart rate and pulse, and can be worn for a long time with low power consumption design. In the system design, 5V voltage power supply is selected, and STM32F103C8T6 has serial communication function pin connection. The interface circuit of pulse heart rate sensor module is shown in the following figure.

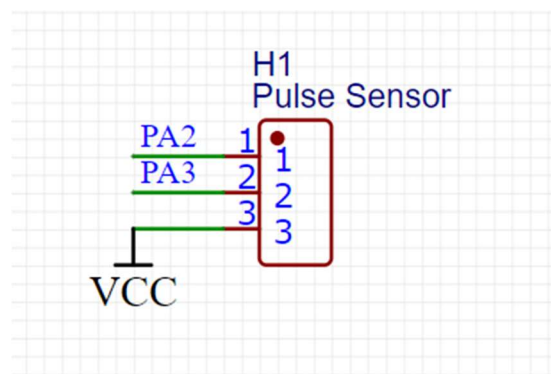


Figure 3. CPU pulse heart rate sensor module

2.3. CJMCUs -MMA9555L step counting module

The MMA955L is a highly accurate and responsive pedometer module designed specifically for counting steps and detecting step size. By using advanced MEMS (Micro-Electro-Mechanical Systems) technology and intelligent algorithms, it is able to accurately identify the human body's walking movements and count and record the number of steps in real time. Using advanced sensor technology, the MMA955L is able to accurately identify walking movements and accurately calculate the number of steps in each step, which can instantly detect the human walking movement and update the step count immediately. This fast response feature ensures the accuracy of statistical results. In addition to the step counting function, the MMA955L also has additional motion sensing detection capabilities. It can perform threshold detection or wake-up detection for monitoring other movements.

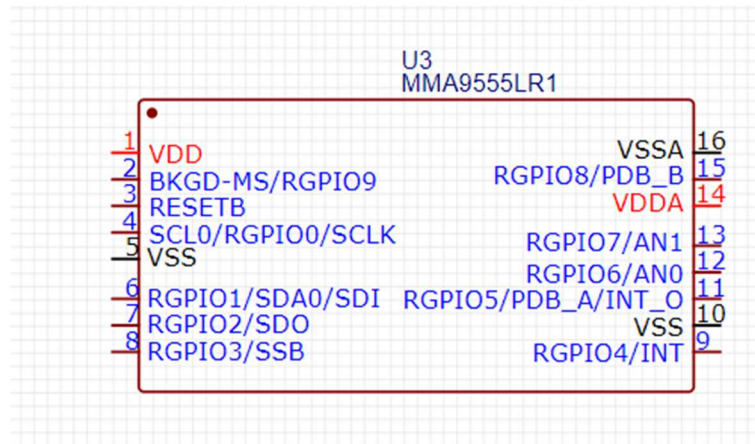


Figure 4. CJMCU-MMA9555L step counting module

2.4. MLX90614 Infrared Temperature Measurement Module

The system uses MLX90614 temperature sensor as the temperature data acquisition module. The temperature sensor is composed of an infrared detector and a signal processing circuit. Its working principle is to emit infrared to the test object through an infrared emitter, and then the infrared detector receives the infrared reflected by the measured object, and then outputs the digital signal. The sensor also includes an ambient temperature compensation function, which can eliminate the impact of ambient temperature on measurement errors. This system uses SMBus digital interface to connect with STM32 single chip microcomputer. The single chip microcomputer sets its internal working mode through SMBus communication protocol to achieve the target of temperature data collected. The interface circuit of the temperature measuring module is shown in Figure 5 below:

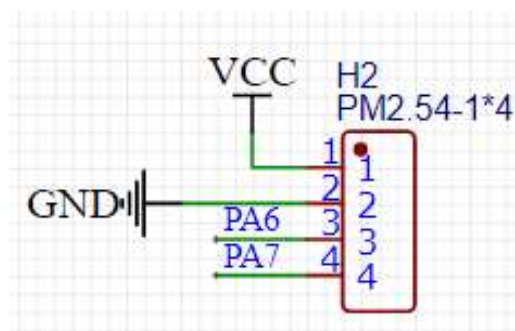


Figure 5. Temperature measurement module

2.5. HC-08 Bluetooth 4.0 Module

The HC-08 Bluetooth 4.0 module is a low-power and low-cost wireless communication module designed for Internet of Things applications. It uses the Bluetooth 4.0 protocol, supports the Bluetooth Low Energy (BLE) mode and the Generic Attribute Profile (GATT) protocol, and can communicate with various Bluetooth devices. The module has the characteristics of small size, low power consumption, high reliability, etc., and can be widely used in battery-powered equipment. It is equipped with a powerful processor chip that can communicate with external MCUS or other devices via a UART serial port, and provides users with an easy-to-use AT instruction set. The module also has a wealth of peripheral interfaces, including GPIO, ADC, PWM and other interfaces, which can be easily extended and applied to various IoT devices. At the same time, the module supports the master-slave mode and can communicate as a central device or a slave device to meet the application requirements in different occasions [2]. The interface circuit of HC-08 Bluetooth 4.0 module is shown in Figure 6 below:

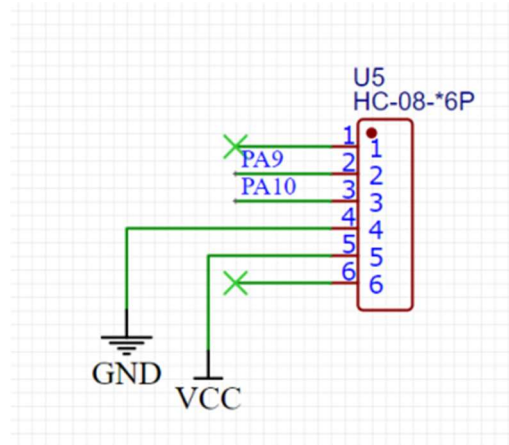


Figure 6. HC-05 Bluetooth module

2.6. SIM900 Wireless Data Transmission Module

GSM wireless data transmission module is a device used to achieve wireless communication, which uses Global System for Mobile Communications (GSM) technology to achieve remote data transmission and communication [3].

The module has a high degree of integration and stability, built-in GSM communication chip and related circuits, data transmission through the mobile phone network. It supports communication protocols such as GPRS (General Packet Radio Service) and EDGE (Enhanced Data rates for GSM Evolution), enabling high-speed and stable data transmission around the world. The GSM wireless data transmission module can send the data collected by the pulse heart rate sensor module to the specified server or cloud platform through communication protocols such as GPRS or EDGE.

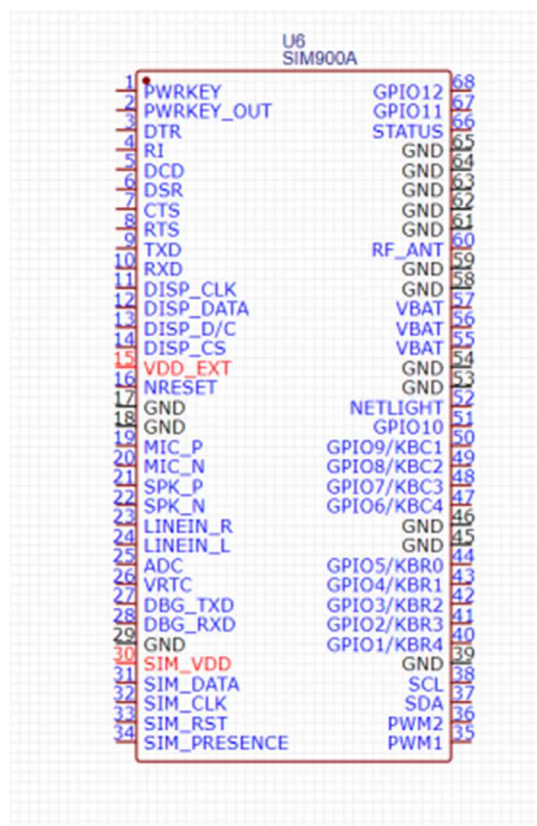


Figure 7. SIM900 wireless data transmission module

2.7. OLED Display Module

OLED module is a display device using Organic Light-Emitting Diode (Organic light-emitting Diode) technology. It has the characteristics of high contrast, wide viewing Angle, fast response and low power consumption, and is widely used in the display interface of electronic products. OLED modules use organic materials as a light-emitting layer, and when an electric current passes through, the organic material will glow, forming a display of images or text. Compared to traditional liquid crystal display technology, OLED modules do not require a backlight, so they can achieve thinner, lighter and more flexible designs. At the same time, OLED modules are able to achieve true black, with contrast and color saturation far exceeding that of LCD displays. It has high integration and stability, and can communicate with the main control device through serial port, I2C, SPI and other interfaces. The main control device can send the display content, control brightness and color operation instructions to the OLED module, so as to achieve a specific display effect. The interface circuit of OLED display module is shown in Figure 8 below:

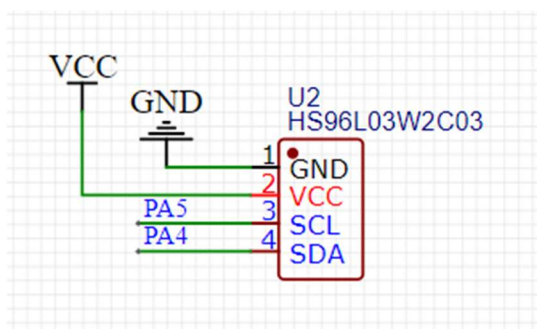


Figure 8. OLED display module

2.8. Buzzer Alarm Module

In this scheme, a buzzer-based alarm module is designed to monitor the upper limit of human body temperature and the abnormal heart rate of medical staff. When the temperature data and heart rate are detected to exceed the set threshold for many times, the alarm circuit will be automatically triggered and the buzzer will buzz for a long time. Conversely, when the temperature and heart rate are in the normal range, the buzzer is automatically turned off. In this way, alertness can be increased and the safety of medical staff can be better guaranteed. The sensor interface circuit is shown in Figure 9 below:

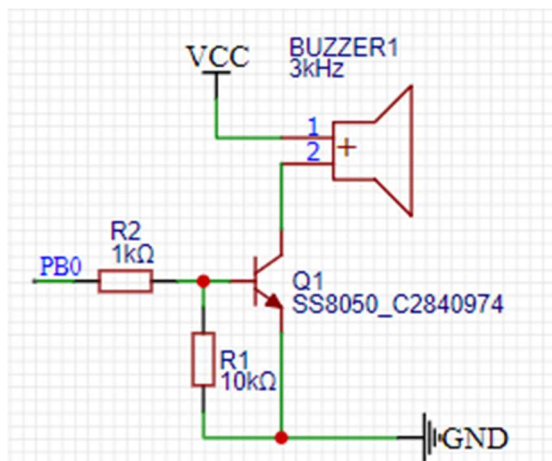


Figure 9. Buzzer alarm module

3. Software Design of Medical Monitoring System

Because of their busy work, medical staff often neglects to take care of their own health conditions, which often leads to various health problems for doctors, nurses and other medical staff. For example, overwork for a long time leads to the decline of their own resistance, when the body's heart rate has several abnormal fluctuations, the body's own immune system is at a low ebb after working for a long time, and the body temperature is in an abnormal range. With the continuous development and improvement of medical technology, intelligent medical monitoring system came into being, this system can provide personalized health monitoring services according to the physical condition and working status of medical staff, and help medical staff to keep healthy at all times.

The system starts to start, first initialize the equipment, and then drive the step meter module and temperature measurement module to detect the motion state and body temperature of the human body, and record it in the display module. The relevant data is sent to the upper computer software through the Bluetooth module, and people can monitor the physical condition of medical staff through the upper computer software. At the same time, the device itself also sets a normal range for the indicators of medical staff. When the user's body temperature and heart rate exceed the preset range, the buzzer module will give an alarm and send an abnormal message to the mobile phone to remind the medical staff that their physical condition is abnormal. If the medical staff's physical indicators are in the normal range, the system considers that the monitoring process is completed and carries out the next cycle of monitoring. The main process of medical monitoring system software is shown in Figure 10.

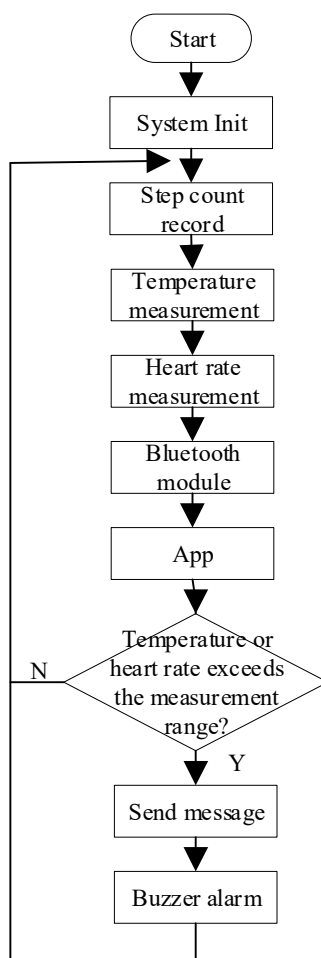


Figure 10. Main flow diagram of system software

4. Conclusion

The healthcare monitoring system is an intelligent solution designed to provide comprehensive health monitoring and management services to ensure the health and work quality of healthcare workers. By using STM32 single chip microcomputer as the core controller, the system monitors and evaluates the physiological parameters, working status and environmental information of medical staff in real time, and provides corresponding suggestions and early warnings. The medical monitoring system has the functions of heart rate monitoring, step statistics, temperature measurement, alarm reminder, SMS reminder and so on. At the same time, according to the health data and working status, to provide personalized health management programs and early warning mechanisms, timely detection and solution of potential health problems. In addition, the equipment is simple to operate, complete functions, and the appearance design is simple, generous and beautiful, which makes the advantages of the equipment more obvious. Overall, the healthcare monitoring system is a comprehensive solution designed to provide intelligent health monitoring for healthcare workers. Its application will promote the development of the medical industry and promote the career development and health development of medical staff.

Acknowledgments

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