Human Physiological Parameter Detection System Based on Android and Arduino

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Abstract. According to the need of real-time monitoring of the human physiological parameters, a human physiological parameters detection system based on Android and Arduino is proposed. Human body temperature and pulse value are measured by the detection circuit of Arduino, and these data are transferred to mobile devices via Bluetooth Low Energy (BLE). The application software based on Android system displays and stores these physiological parameter data. When the measured value is beyond the threshold, it would send warning information to the guardian and meanwhile send tips to the testee. The experimental results show that the system meets the requirements of real-time monitoring and recording of the human body physiological parameters, and alarms when it detects abnormal body temperature or pulse value.

Introduction

In the present society, with the fast pace and high intensity of work, people don’t have enough time to exercise; gradually they would fall into a variety of diseases. However, most of the time, it is hard for them to be aware of the subtle change of the body. It is often that when they are not feeling good, they have already been ill. So, more and more attention is paid to the mobile medical apparatus which can give a real-time reflection of the change of the human body. In this context, a human physiological parameters detection system based on Android and Arduino is proposed which can give a real-time monitoring, storing of the physiological parameters and alarms when things get abnormal [1].

System Frame Design

The system framework is shown in Figure 1, consists of two parts, one is physiological parameter detection circuit based on Arduino, the other part is the application software based on Android mobile device. The wireless communication between physiological parameter detection circuit and Android mobile device is BLE.
Detection circuit is used for collecting pulse parameters and body temperature of the testee, and it will send measure parameters to the BLE module of detection circuit via a serial port. The measurement data are transmitted in the form of broadcast by BLE module.

After the application software on the mobile device is launched, the mobile device and the detection circuit are connected to receive the data. The data is separated, extracted and compared with the threshold. When it exceeds the threshold, the mobile device will send alarm information to the guardian. In addition, the detection data is stored in the mobile device to be used as the basis for the diagnosis and treatment.

**Detection Circuit Design**

This design, the detection circuit is used to detect body temperature and pulse parameters, and to send out metrical data through wireless transmission module. As shown in Figure 2, the detection circuit consists of pulse sensor, temperature sensor, wireless module, controller and power supply.

**Pulse Detection**

There are generally three methods to detect the pulse: the first method is to extract pulse value from ECG signal; Secondly, when the pressure sensor measures the blood pressure, it will receive pressure fluctuations, with which to calculate the pulse; the third one is
photoplethysmography (PPG). While the first two measuring methods can confine the action of the testee, so they are not suitable for mobile medical equipment, therefore, measurement of pulse using third methods in this design.

Sensor Pulse is selected in the design, which is based on the principle of PPG. The Pulse Sensor can transmit analog signal to MCU through the wires, then MCU converts analog signals into digital signal, which should be duly processed before we get the pulse parameters. Pulse Sensor, using the 515 nm (the oxygen and hemoglobin in the arterial blood are selected by the light source of this wavelength) green light LED as light source, can reflect the tiny pulse changes in skin surface. The reflected light generated by the light source is due to the change of the pulsation period. Reflected light is received by a photoelectric converter, and converted into a corresponding electrical signal. The change of the electrical signal cycle is the pulse rate.

Temperature Detection

There are two types of temperature measuring method, namely, contact-type and non-contact-type. Non-contact mainly adopts the infrared temperature measurement, by which temperature value can be gained without making contact with the patient’s body, but the error is comparatively bigger. This design uses DS18B20 temperature sensor to perform contact temperature measurement, as to reduce the error and to accurately reflect the variation of body temperature.

In the experiment, the sensitive part of DS18B20 is placed directly on the skin of the testee, while the other part is wrapped by a heat insulating material to reduce the impact of external environment on it. Generally, it requires that the accuracy of the body temperature measurement is 0.1 °C, sets the A/D conversion accuracy of DS18B20 to 12bits, in this case the measuring precision is 0.0625 °C which will surely satisfy the measurement requirements.

Communication and Controller Design

Detection circuit and the mobile device are connected through the wireless communication, and it needs to maintain real-time communication. And the power consumption of ordinary bluetooth is very high, so it is not suitable for mobile medical equipment. That’s why the experiment chooses BLE as a wireless communication module. And API in SDK of Android 4.3 and higher version has the function of operating BLE, so it can be very convenient to operate the mobile device integrated BLE module.

The signal detected by Pulse Sensor is analog signal, so the controller should have an analog input. And DS18B20 needs a digital I/O port, besides, the BLE module needs to communicate with the controller via a serial port. So the controller should also contain these three interfaces. Arduino is convenient, simple and easy to use, and it is an open source platform for hardware development. Arduino Uno is selected as the controller in the experiment, which contains 14 digital I/O ports, six analog inputs, and a USB serial port, etc., fully meet the interface requirements in the test.

Mobile device Software Design

In the design, mobile devices are used for data receiving, storage, and abnormal alarm, etc. to meet the needs of real-time monitoring and free movement of the testee. According to the classification system the mainstream mobile devices mainly can be classified into three kinds: Android, IOS and Windows Phone. Android equipment is selected in the design, its market
share is high, the price is low, and all system version not lower than Android 4.3 devices support BLE. The function of the mobile device application software mainly includes the following:

**Receiving and Processing of Data**

When the testees wear testing equipment in a wrong way, measurement data is meaningless. Normal adult pulse is 60 to 100 beats per minute (BPM), the average is about 72 BPM. The pulse of the elderly is slower, and it’s about 55 to 60 BPM. The normal person’s pulse frequency is regular, it won't appear the phenomenon of different pulse interval length, and it also won't appear the alternation of strong pulse and weak pulse. In addition, the exercise and passion can quicken the pulse, on the contrary, rest and sleep slow the pulse. If the pulse frequency of an adult is more than 100 BPM, called tachycardia; if it is less than 60 BPM, called bradycardia. And the pulse of the ordinary people after strenuous exercise is more than 200 BPM, and temperature value will rise accordingly.

According to related articles, surface temperature on the inside wrist of a normal human is about 33.2°C to 34.6°C. Exclude the environmental impact, when the temperature is above 35.1°C, it is taken as fever. When it is lower than 31.2°C, it is taken as hypothermia.

From the above, the design is to set the limit temperature taken on the inside of the wrist is 20°C to 42°C (shell temperature is lower than the anus temperature, it should contain all the effective values as far as possible, and exclude the interference of external environment). So the detected temperature value is lower than 20°C or higher than 42°C, these data, as invalid values, will not be processed. And when the pulse value is greater than 200 BPM while the temperature value is lower than 30°C is also regarded as an invalid value (because when the body temperature is low, pulse value will surely decline).

**Storing Data**

SQLite is used to store the measurement data, which is the internal database of Android. The properties of the table in the database include: name, temperature value and pulse value and recording time. The capacity design database for 2 days, the full 2 days after the first day will automatically delete the data recorded in circulation.

**Abnormal Alarm**

When the measurement data is invalid, it prompts the user to check whether the testing equipment is worn correctly, and these data will not be processed. The data are processed and analyzed when the value is valid. If the temperature is higher than 35.1°C or lower than 31.2°C, and adds up to three times, it sends a warning alarm for abnormality. When the pulse value is greater than 100 BPM or less than 50 BPM (considering that the elderly pulse value is comparatively lower) and adds up to three times, it sends abnormal pulse warnings. Warning in the form of SMS will be sent to the guardian, and also alert the testee. The program execution process is shown in Figure 3, and the data processing process is shown in Figure 4.
**Experiment Analysis**

The pulse sensor and the temperature sensor are respectively fixed to the testee’s finger and wrist inside. Launch the App on the phone, observe data shown on the mobile phone as shown in Figure 5, and data storage is shown in Figure 6.

![Figure 5. Metrical data shown on App.](image)

![Figure 6. Check the historic data.](image)
Put the temperature sensor on a 40°C hot-water bag, and measured value is greater than the setting threshold, abnormal temperature alert is sent after a period of time. After the testee’s strenuous exercise, test his or her pulse rate, and measured value is greater than the setting threshold, it sends after a period of time the pulse abnormal alarm.

**Conclusion**

The human physiological parameters detection system can give a real-time detection of human body temperature and pulse parameters, and it can also make the detected data display and store in the intelligent mobile device of Android. When the measured effective value is beyond the preset threshold, it sends the corresponding alarm information to the guardian, and alert the testee. The experimental results show that the combination of the hardware detection circuit and the intelligent mobile device can meet the needs of real-time monitoring, recording and early warning to the testee.

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**References**


