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The Analysis of the Heartbeat Detection & Sensory Temperature Detection

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Abstract. With the maturity of medical technology, the information emitted by human body parts can be detected by doctors and used as critical indicators. Usually, doctors conduct basic tests on patients by measuring body temperature and heart rate. Currently, hospitals still measure these values separately, which leads to low measurement efficiency. This paper analyzes the principles of the two measurement methods and summarizes the temperature and heart rate detection sensor to test the values and achieve simultaneous measurement of both values, thus optimizing medical testing. It also evaluates the accuracy and limitations of the instrument by measuring and plotting the values during human exercise and drawing a bar-line graph based on the image to prove a linear relationship between body temperature and heart rate.

Keywords: Temperature and heart rate sensor, DS18B20 temperature sensor, ST188 heart rate sensor.

1. Introduction

Body temperature is the most basic vital sign, which is very important for daily care and disease detection. The instability of body temperature makes it easy for viruses to invade the body, causing fever and cold. Body temperature imbalance can also cause malfunctions in the body's internal environment and metabolic disorders [1]. The pulse signal transmits comprehensive information about the body. The amplitude, frequency, and pulse wave shape reflect the person's health status and can predict related cardiovascular diseases [2-3]. Abnormal heart rate can easily lead to heart failure and even sudden death. Early detection of heartbeat and body temperature is done through stethoscopes and mercury thermometers. With the continuous development of medical technology, DS18B20 temperature sensors and ST188 heart rate detection sensors have been invented to detect body temperature and heart rate, but they cannot measure both values at the same time on a single instrument, which cannot allow doctors to detect and determine the patient's body temperature and heart rate more quickly. To make it easier for doctors and patients to measure body temperature and heart rate, this paper combines the two sensors on a single microcomputer based on their basic principles. This paper uses a literature review method to analyze each component in combination with different literature. And relevant tests are conducted to prove the feasibility.

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2. Systematic design

To research whether sensor detection can optimize the medical system, the body temperature and heart rate detection sensor consists of DS18B20 temperature sensor, ST188 heart rate detection sensor, STC85C52 microcomputer and LCD1602 display screen. The DS18B20 temperature sensor and ST188 heart rate detection sensor convert the detected value into a digital signal and transmit it to the STC85C52 microcomputer for processing, and then send the signal to the LCD screen to display the value. The body temperature and heart rate detection sensor and smart watch are used to detect the body temperature and heart rate under certain training intensities, compare the accuracy of the two numerical difference test instruments, and find the relationship between body temperature and heart rate through mapping, so that medical personnel can quickly detect the body temperature and heart rate of patients, and achieve the purpose of providing convenience for the future medical field and convenient services.

2.1. DS18B20 Temperature sensor

The DS18B20 is a small, high-precision, and highly resistant-to-interference single-wire digital temperature transducer produced by the Dallas Company in the United States. It has the characteristics of low consumption and high performance. Its measurement range is -55°C to 125°C, and the error range is ±0.5°C [4-5]. Its internal structure has 64-bit address storage, thus it can achieve multi-point temperature measurement without interference. The low-temperature coefficient oscillator in DS18B20 has a stable oscillation frequency and is less susceptible to temperature, used to generate a fixed frequency pulse signal to send to subtraction counter 1, while the high-temperature coefficient oscillator has a more obvious oscillation frequency change with temperature than the low-temperature coefficient oscillator, and the signal generated by it is used as the pulse input for subtraction counter 2. It contains a counting gate, which opens when the counting gate is open, and DS18B20 counts the clock pulses generated by the low-temperature coefficient oscillator, thereby completing the temperature measurement. The opening time of the counting gate is determined by the high-temperature coefficient oscillator, and the minimum measurement range value - 55℃ corresponding base number is placed in the temperature register and counter 1 before each measurement. Counter 1 and the temperature register are preset to the base value corresponding to - 55℃. Counter 1 performs the subtraction function, performs subtraction counting on the clock pulses generated by the low-temperature coefficient oscillator, and when the preset value of Counter 1 is reduced to 0, the value of the temperature register will be increased by 1, the preset value of Counter 1 will be reloaded, and Counter 1 will start counting the clock pulses generated by the low-temperature coefficient oscillator again. Repeat this process until counter 2 counts to 0, stop adding the value of the temperature register. The value in the temperature register at this time is the measured temperature. The slope accumulator in the figure is used to correct the measurement error temperature and convert the non-linear values into linear values. Its output is used to correct the preset value of the subtraction counter, as long as the counting gate is not closed, the above process is repeated until the value of the temperature register reaches the measured temperature value.

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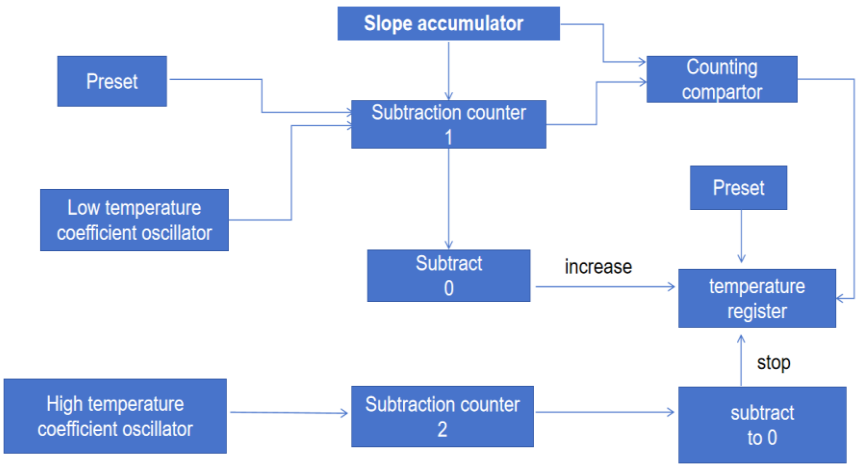

Figure 1. The block diagram of internal temperature measurement circuit of DS18B20

2.2. ST188 Heart rate sensor

When a user gently presses their finger onto the ST188 photoelectric sensor and waits for five seconds, the infrared photodiode emitter of the sensor emits infrared rays. The blood reflects the infrared rays and is subsequently received by the receiving end. Since the light transmittance of blood varies with the user's pulse beats, the frequency of the pulse signal also changes accordingly. This indirectly leads to different amounts of reflected infrared rays absorbed by the phototransistor of the sensor, resulting in only a weak pulse signal being output. The pulse signal is extremely unstable and is often influenced by changes in the environment, human physiology, and psychology. The collected pulse signal, after undergoing filtering, shaping, and amplification, converts the optical signal obtained by the sensor into an electrical signal that is convenient for processing by the single-chip microcomputer. It is input to the external interrupt 0 port of the single-chip microcomputer. Simultaneously, the internal timer of the single-chip microcomputer is utilized to calculate the time, measure the number of pulse beats within one minute, and send it to the LCD liquid crystal for real-time display. During the measurement process, if the LED lamp flashes a red light uniformly, it indicates that the measured value is accurate. On the contrary, it is necessary to re-adjust the finger position or pressing intensity until it stabilizes. Additionally, the user can also set the upper and lower limit alarm values for the pulse through the buttons. When the measured pulse value is outside the range of the upper and lower limits, the single-chip microcomputer issues an alarm instruction, causing the buzzer to emit an alarm prompt.

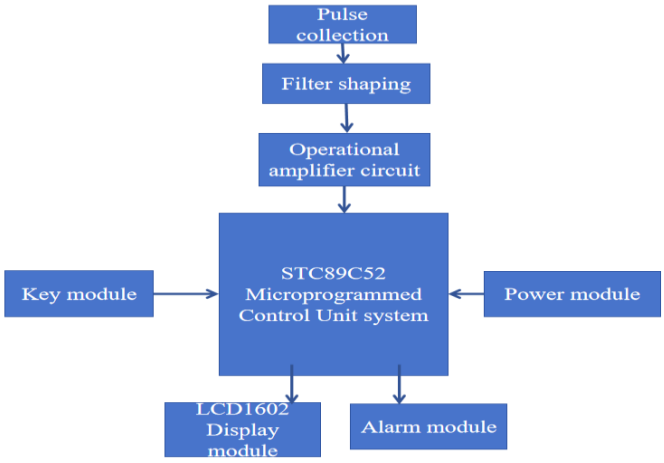

Figure 2. Operating diagram of ST188

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2.3. STC89C52 Microcontroller

The STC89C52 microprocessor is a low-power, high-performance microprocessor produced by STC Company [6]. On the one hand, it can recognize and judge the temperature transmitted by the DS18B20 sensor, and if the temperature is outside or below the normal human body temperature, it will execute the alarm instruction. On the other hand, it filters out the useful signals from the ST188 signal uses the internal timer to calculate the number of heartbeats within the set time, and then calculates the heart rate. Finally, it transmits the values of both to the LCD. If the detected body temperature and heart rate values are greater than or less than the normal values, the STC89C52 microprocessor will automatically execute the alarm instruction and control the buzzer to give a warning.

3. Analysis and results

3.1. Results

The designed body temperature and heart rate detection sensor is used to measure the body temperature and heart rate at different exercise times within the acceptable intensity range, and the value is compared with the value detected by the smartwatch. Through data sorting and analysis, the accuracy of the sensor measurement is verified and the relationship between body temperature and heart rate is found. During the process, 5-89min is the stage of gradually increasing training volume, 89min is the stage of training intensity reaching the top, and 89-120min is the stage of gradually decreasing training intensity. The parameter "watch" refers to the smartwatch detection value, "device" refers to the temperature and heart rate detection sensor detection value; "bpm" refers to heart rate value, and "T" refers to temperature value.

Table 1. The value of the smartwatch and the temperature and heart rate detection sensor in different time periods [7]

	watch		device	
t/min	bpm	T/℃	bpm	T/℃
5	76	36.8	75	36.8
12	82	36.8	79	36.9
24	89	37.5	89	37.5
46	98	37.6	95	37.7
58	134	38.5	134	38.4
67	145	38.9	153	38.9
89	180	39.4	184	39.5
100	142	37.5	140	37.4
120	103	36.5	105	36.5

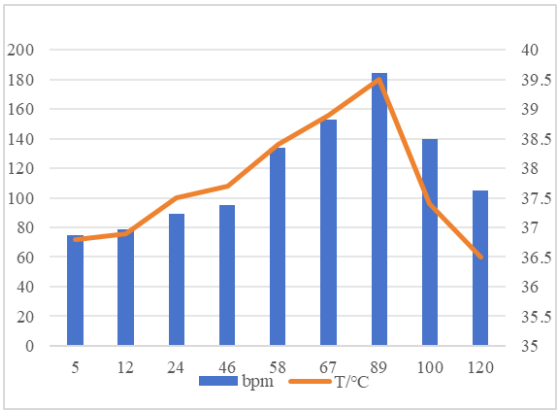

Figure 3. Bar-line chart of body temperature and heart rate

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Through the values measured by the two instruments, it can be judged that the temperature and heart rate detection sensor detection value is relatively close to the smartwatch detection value with the error being within the acceptable range. In the case of strong lighting, the heart rate detected by the temperature heart rate detection sensor has a large difference. Because under strong light, the receiver cannot effectively receive all the reflected light after the infrared radiation emitted by the ST188 heart rate detection sensor is reflected by the blood. From the bar-line chart of body temperature and heart rate, it can be seen that with the increase of exercise time (5-89min), body temperature has a linear relationship with heart rate, while with the decrease of training intensity (89-120min), body temperature has a linear relationship with heart rate. The relationship between body temperature and heart rhythm is still linear. In summary, heart rate and body temperature show a linear relationship at different temperatures.

3.2. Analysis

The experiment analyzed the temperature and heart rate detection sensor, and the results showed that the temperature and heart rate detection sensor could accurately measure the body temperature and heart rate value. Therefore, the temperature and heart rate detection sensor can effectively reflect the physiological state of the human body. In low light, the heart rate can be measured more accurately. In the future, it can be widely used in the medical field and convenience services, so that the public can detect their own body temperature and heart rate value more quickly, and make faster measures for abnormal body temperature and heart rate value.

4. Conclusion

By using the temperature and heart rate detection sensor and smartwatch within the acceptable intensity range of the human body, the body temperature and heart rate are respectively detected at different exercise times, and the detected values are compared to make a graph. From the above experiments and data analysis, we can conclude that the exercise program is too intense and too long, which is not conducive to the balance adjustment of the human body. So proper exercise time is good for health. However, the heart rate value measured by the instrument under strong light is not accurate, so the ST188 sensor can be made into a black opaque clip, and the heart rate value can be accurately measured by clamping on the thumb

With the development and maturity of body temperature and heart rate detection technology, it is hoped that this technology can not only be applied to medical personnel in the medical system to quickly detect the body temperature and heart rate value of patients, but also be applied to smart clothes that automatically regulate body temperature. When the detected body temperature and heart rate value is too large or too small, smart clothes can realize the function of cooling or heat preservation of the human body by adjusting the material of clothes. The technology will benefit sports enthusiasts and the elderly.

References

[1] Peng Guili and Liu Zhigui.Design of infrared body temperature device[J].microcomputer information,2006,22(05Z):67-69.

[2] Yang Jian. Research on methods of pulse wave signal acquisition and analysis. Computer and information technology. 22.3(2014):53-55,59.

[3] Li Dongfang Comparative analysis of center rate and exercise intensity of different groups of students in PE class. Contemporary sports technology.7.6(2017):234-234,236.

[4] Liu Haipin and Su Shibin. Design of temperature acquisition system based on DS18B20. scientific and technological information. ,11(2009):26-26.

[5] Wu Chunlong. Design of high precision digital temperature measurement system -- composed of KeilC51 single chip microcomputer and DS18B20 temperature sensor. Computer programming skills and maintenance,17(2012):87-89,93.

[6] Zhong Shihong, Ye Shunhua, Wang Lixian, LUO Xiaoyan. Design of Air Quality detection system based on single chip computer [J]. Science and Technology Square. 2009(7):169-171.

DOI: 10.54254/2755-2721/109/20241367

[7] LIU Linlin, Qiu Hongxing, Shi Meilin, Zhuang Yinping, Gong Ping, Xu Kai. Design of portable heart rate monitoring system based on photoelectric sensor [J]. Image Technology. 2018,30(2):85-88.