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A HEART RATE MONITORING AND NOTIFICATION SYSTEM USING ARDUINO PLATFORM

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ABSTRACT

Heart rate measurements are widely used for various purposes that require an accurate and reliable method to measure it. The most common method used is by ECG, which is widely available and non-invasive. Another non-invasive, photoplethysmography (PPG) technology can also be used to measure blood pressure and oxygen saturation.

KEYWORDS: heart rate, monitoring system, photoplethysmography, sensor, Arduino

1. Introduction

In order to enhance the patient care and people's quality life, biomedical engineering integrates the design and scientific abilities of engineering with the medical and biological sciences. The medical devices are intended to be used in illness detection, treatment, cure or prevention [1-9].

The number of people with different cardiovascular risk factors is expanding alarmingly [10]. In addition, the worldwide rate of cardiovascular malady is expanding as the world's population ages and as ways of life (and in this way chance components) in low and middle-income nations become more comparative to those of wealthier countries [11-13].

Identifying and monitoring individual risk factors, as well as aiding with lifestyle adjustments, are critical components of cardiovascular disease treatment.

Monitoring the patient's heart rate provides a positive contribution to the monitoring of cardiovascular disease. There are several procedures found in the literature for taking heart rate measurements on mobile phone applications [14-26]. These procedures can be through physical contact and non-contact. The photoplethysmography technology is used to measure blood pressure and oxygen saturation [27]. The heart rate sensor is used to identify changes in heart rate [28-31].

In this study, we aim to develop a wearable heart monitoring system, which could help heart patients to improve their quality of health and serve as a wake-up call for any serious heart problems. The system provides real-time heart rate monitoring, which, patients with cardiovascular disease could benefit of, by enabling early detection of heart irregularities.

2. Experimental procedure

Referring to the block diagram proposed in Figure 1, the heart monitoring system comprises a sensing unit and a receiving unit.

The detection unit consists of the photoplethysmograph sensor, the microprocessor and the Bluetooth transceiver module. The receiving unit is the mobile phone with Bluetooth connection. The Bluetooth module has 6 pins. State and En pins will not connect in this case, instead VCC, GND, TX and RX pins will be connected as illustrated in Figure 2. The pulse sensor records the pulse signal, and the microcontroller analyses the received signal.

The microcontroller performs the calculation, the decision and finally it will send the heart rate data to: the monitor serial of the Arduino IDE program, to the OLED screen and to the Bluetooth module, following mobile phone connected to this module to receive the transmitted data (Figure 3).

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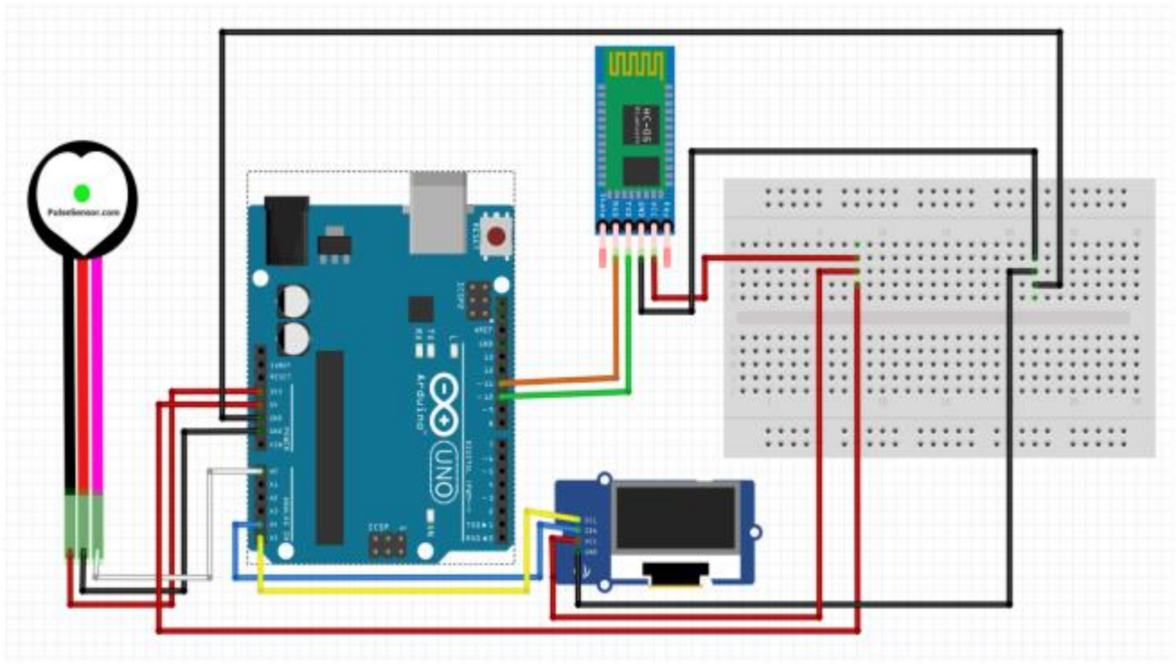

Fig. 1. *Block diagram of the proposed system architecture*

The microcontroller consists of a central processing unit (CPU), memory and various peripheral devices. The typical function of the microcontroller is to read the received data, perform calculations and control the environment based on the calculated data.

The standard pulse sensor SEN-11574 has three pins: Signal (S), VCC(+) and GND(-). According to the properties of this sensor, if the heart beats, then there is a change in voltage and vice versa. By connecting the test pin with the logic state, the change in the heart rate occurs. Therefore, if the test pin is set too high, it means that the finger is placed on the sensor, it detects the change in pulse and then the sensor gives a specific beat of the heart in the form of voltage (5V). Also, if the logic state is set low, it will not give any output voltage. This idea is further extended by replacing the logical state with a variable resistor. By setting the value of the resistor, the voltage is controlled, which means the sensor will give different readings in signal form (Figure 3). In Figure 4, the system architecture of heart rate monitoring device developed in this research is represented.

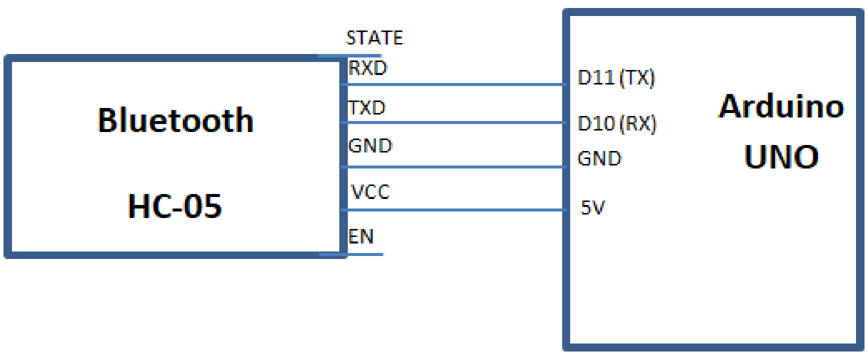

Fig. 2. *The pins connection between Bluetooth module HC-05 and microcontroller Arduino UNO*

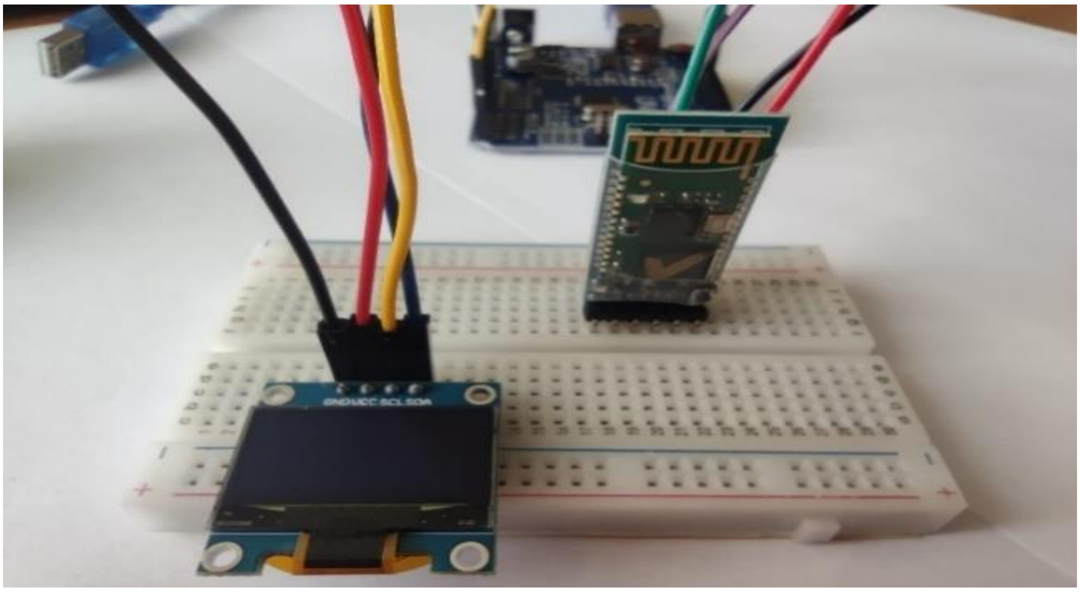

Fig. 3. *Connecting the OLED screen and the Bluetooth module to the breadboard*

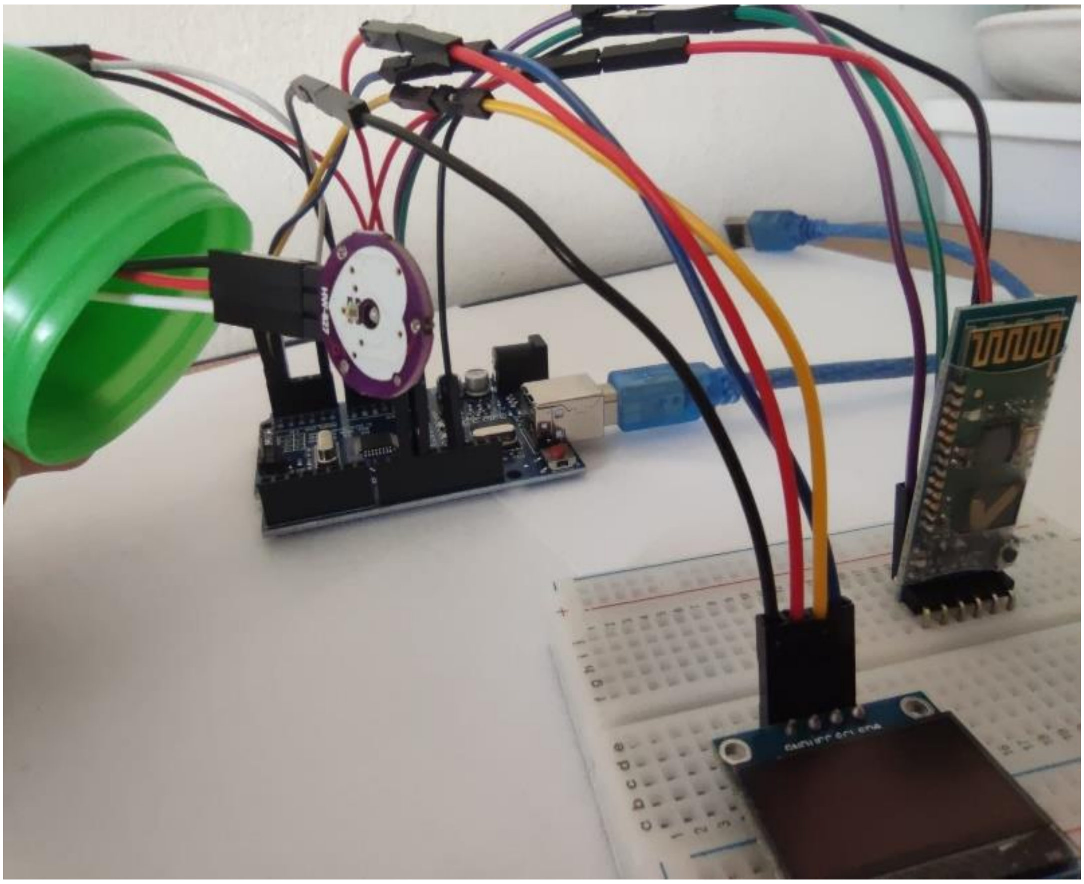

Fig. 4. *The system architecture of heart rate monitoring device*

3. Results and discussions

Once the components are connected, the USB cable must be mounted between the Arduino board and the laptop. The following will be selected from the Arduino menu: the corresponding port and the board, then to test the created code, press the Verify button, which compiles the code, to find the errors and be able to solve them. The code steps are: introducing libraries, defining variables, and the two essential functions, void setup and void loop. In Figure 5, the initialization stage of serial monitor, Bluetooth module and OLED screen is presented. After the initialization stage, the actual functions follow, where information is calculated and conditions can be set. The next step in the void loop function is to make the display part, for the 3 types of monitors. This part is done with the loop function, the principle of a loop, precisely to continuously calculate the values of the pulse and to repeat the commands.

The monitoring system display and the results on the OLED screen and phone app Ardutooth are presented in Figure 6.

The results verification methodology is necessary to ensure the accuracy, sensitivity, specificity and precision of the heart rate monitor. The device output verification procedure includes comparing the device output values to the output values from an existing heart monitoring device.

In Figure 7 it can be seen how the value recorded at that time by the pulse sensor integrated in the developed system is in accordance with the value recorded by the pulse oximeter.

```
void setup()
{
  display.begin(SSD1306_SWITCHCAPVCC, OLED_ADDR);
  Serial.begin(9600);
  B.begin(9600);
```

***Fig. 5.** The initialization stage in the Arduino platform*

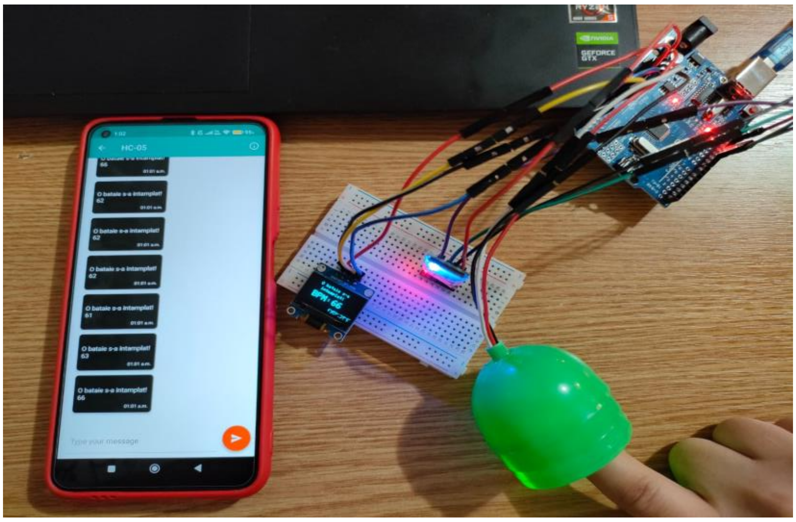

***Fig. 6.** Monitoring the system display and the results on the OLED screen and phone app*

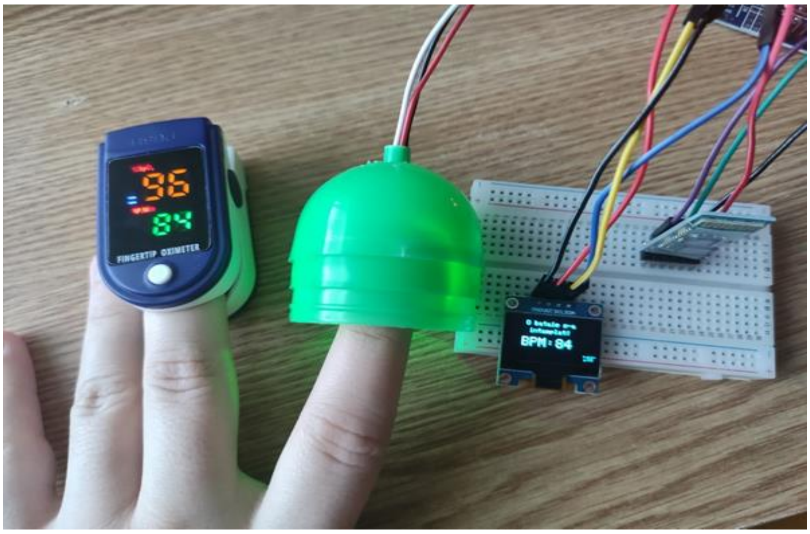

***Fig. 7.** The results validation for the heart rate system proposed using a pulse oximeter*

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4. Conclusions

This study integrates engineering design and problem solving with biomedical sciences to improve wearable heart monitoring systems, which could help heart patients improve their quality of health and serve as a wake-up call for any serious heart problems. The pulse monitoring system uses the principle of photoplethysmography (PPG) to detect heart rate values. By compiling proper coding for heart rate detection on the Arduino board, the results showed that heart rate could be detected from variations in blood flow in the finger.

The pulse sensor (SEN-11574) effectively detects heartbeats, and the validation process against a pulse oximeter confirms the accuracy of the developed system.

Using Bluetooth technology, the heart rate data is transmitted in real-time to a connected mobile phone, allowing for continuous monitoring.

By offering real-time alerts, the system helps improve response times to irregular heartbeats, potentially preventing serious health consequences for patients with cardiovascular conditions.

Moreover, such systems can also be implemented in hospitals or clinics for continuous patient monitoring by using wireless communication system.

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