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Design and Construction of Heart Beat Sensor Using Arduino

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Abstract: This project addresses the methodology for real-time monitoring of a patient's heart rate. The proposed system utilizes a sensor that detects the heartbeat, which is managed by a microcontroller. The heartbeat readings are presented on an LCD monitor. The heartbeat sensor is employed to capture the heartbeat over a designated time period and calculates the beats per minute. The primary aim is to continuously monitor the patient's heart rate, which should be accessible to the attending physician. In hospital settings, patient health monitoring is conducted by healthcare staff, who consistently check and maintain records of the patient's heart rate. The essential components of this system comprise a power supply, an Atmega328 microcontroller, a heartbeat sensor, and an LCD display.

Keywords: Design heartbeat, Heart rate reading, Implantation of the heart rate device

Introduction

In the contemporary landscape, the advancement of wireless technology has been significantly improved to address the demands of remote control and oversight. Remote patient monitoring represents a technological solution that enables the observation of patients outside of clinical or hospital settings. This approach has the potential to enhance access to healthcare services while simultaneously reducing expenses. Furthermore, remote patient monitoring optimizes the time of both patients and healthcare providers, thereby enhancing the efficiency and dependability of health services [1,2] The heartbeat is one of the primary indicators routinely assessed by medical professionals upon a patient's arrival. Heart rate denotes the frequency of heart contractions and relaxations within a specified time frame, typically measured per minute. This rate differs across various age demographics. For adults aged 18 years and older, a normal resting heart rate is approximately 72 beats per minute (bpm). The heart's efficiency can be considered optimal when the resting heart rate is lower. Infants exhibit a significantly higher heart rate, averaging around 120 bpm, while older children generally have a heart rate of about 90 bpm [3,4] A heart rate that falls below the normal range signifies a condition referred to as bradycardia, whereas a heart rate that exceeds the normal range indicates a condition known as tachycardia. The output from the heart rate sensor is linked to the microcontroller, which processes the data and presents it on an LCD screen while also transmitting it via Bluetooth to the designated receiver [5,6,7] .

2. Aim of The Study

Is to build a high precision heart rate monitoring device by using Arduino that can send the heart rate readings to a mobile phone app via Bluetooth.

2.1 Heart beat monitoring

A heart rate monitor is a personal device intended for users to measure their heart rate in real time or to log it for later evaluation. The early models consisted of a monitoring unit that was linked to the chest through a set of electrode leads. The typical resting heart rate for a healthy adult is approximately 72 beats per minute (bpm), while infants have a resting rate of about 120 bpm, and older children generally exhibit rates around 90 bpm. During physical activity, the heart rate increases progressively and gradually returns to its resting level post-exercise[8,9]. The speed at which the pulse normalizes serves as a measure of an individual's fitness level. A heart rate that is lower than the standard range typically indicates a condition referred to as bradycardia, whereas a higher rate is classified as tachycardia. To measure heart rate, one can place the thumb over the arterial pulsation of the subject, feeling for the pulse and counting the beats over a 30-second interval. The heart rate in beats per minute (bpm) is then calculated by multiplying the counted pulses by two. While this method is straightforward, it lacks precision and may yield inaccuracies, particularly at elevated rates. More advanced techniques for heart rate measurement employ electronic methods. The electrocardiogram (ECG) is a commonly used approach for this purpose, although it is a costly device. Additionally, affordable wristwatch-style monitors are available for real-time heart rate assessment. These devices can provide accurate readings, but their prices often exceed several hundred dollars, rendering them less economical. A heart rate monitor that includes a temperature sensor is an essential instrument for evaluating both the pulse and temperature of an individual or patient. [10]

2.2 Significance of Heart

The heart functions as a pump, circulating blood that is rich in oxygen and nutrients throughout the body to maintain its operations. During physical exertion, the heart rate fluctuates in direct relation to the level of effort being applied. By measuring the electrical signals generated by the heart's contractions, one can readily monitor its rate, which serves various health-related purposes. The heart beats vigorously to deliver oxygenated blood to the muscles while also facilitating the removal of metabolic waste products. Monitoring the heart rate during exercise provides valuable insight into the effectiveness of the workout in enhancing overall health [11,12]

2.3 Measuring heartbeat

Presently, technology encompasses both optical and electrical monitoring systems. The electrical approach necessitates a cumbersome strap that is worn around the chest. In contrast, the optical approach eliminates the need for such a strap, offering a more convenient alternative to the electrical method. Several limitations exist in the development of heart monitors. Initially, it is essential to identify the technology employed for pulse measurement. A cost-effective solution for pulse detection involves the integration of a light-emitting diode (LED) and a photo-sensor.[13]

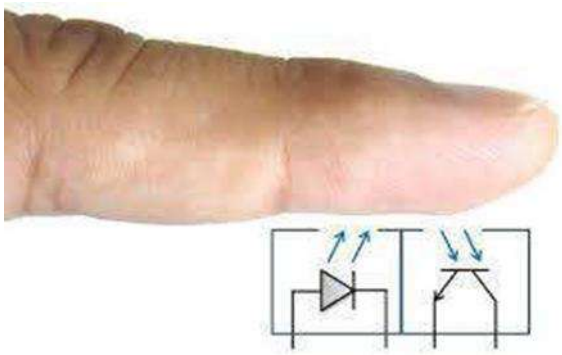
2.4 Electrical Method

The chest strap of a heart rate monitor utilizes electrodes to detect the electrical signals produced by heartbeats. This information is transmitted to the receiver through a radio signal emitted by the chest strap. The receiver subsequently processes this data to calculate the heart rate. Additionally, some monitors feature a "coded signal" that incorporates a unique code within the radio transmission, preventing interference from signals emitted by other nearby devices. While this interference is not always a significant issue, it can be bothersome and may compromise data accuracy. This approach has several drawbacks, including potential inaccuracies and the inconvenience of cumbersome wired connections across the body.

2.5 Optical Method

The optical method leverages the inherent characteristics of small subcutaneous blood vessels, referred to as capillaries, found in areas of the skin with good blood flow, such as the fingertip or earlobe. These vessels exhibit expansion and contraction in rhythm with the heartbeat. A conventional combination of an infrared LED and a phototransistor is capable of sensing these

minute changes as differences in skin contrast. This technique utilizes both transmittance and reflectance principles. It serves as a non-invasive means of measuring heart rate, eliminating the need for any physical attachments or insertions into the body. Furthermore, it is both precise and cost-effective. [14,15]



Optical measuring method

2.6 Wireless Communication

Wireless communication represents one of the most rapidly evolving and dynamic sectors within the field of communication technology. It encompasses the transfer of information from one location to another without the necessity of physical connections such as wires or cables. In a standard communication system, data is conveyed from a transmitter to a receiver situated within a defined range, facilitated by wireless communication technology

2.7 Bluetooth

Bluetooth represents a significant low-range wireless communication technology. It facilitates the transmission of data, voice, Bluetooth technology enables the transmission of audio and data over a distance of up to 10 meters. Most mobile phones, tablets, and laptops are equipped with Bluetooth functionality, facilitating connections to a variety of wireless Bluetooth receivers, audio equipment, cameras, and additional devices.

3. Materials and Methods

3.1 Wireless

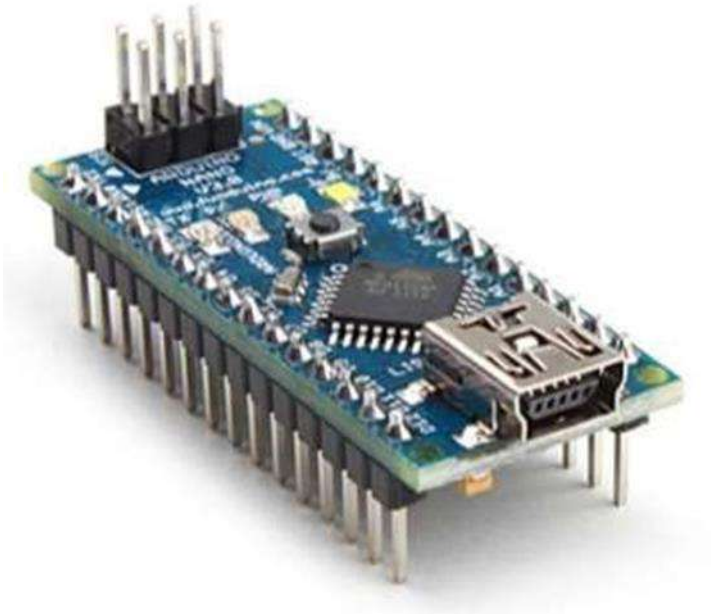
The HC-05 Bluetooth module is utilized for transmitting data to the receiving end. This module is specifically engineered for wireless communication.

HC-05 Bluetooth module

3.2 Micro Controller Unit

Arduino Nano:

It is a small electronic board with a small memory, which is an integrated memory that can be programmed via a computer and consists of 12 digital outputs and 8 analog outputs. There are inputs between the outputs that allow several sensors to be connected to the Arduino. The digital outputs output either 0 or 5 volts, and the analog outputs enable the output of more than 0 to 5 volts. There is also GND, and the board is supplied with power via a UPS cable.



Arduino Nano

3.3 power Supply

Battery Management System : It is an electrical power transmission system

management circuit

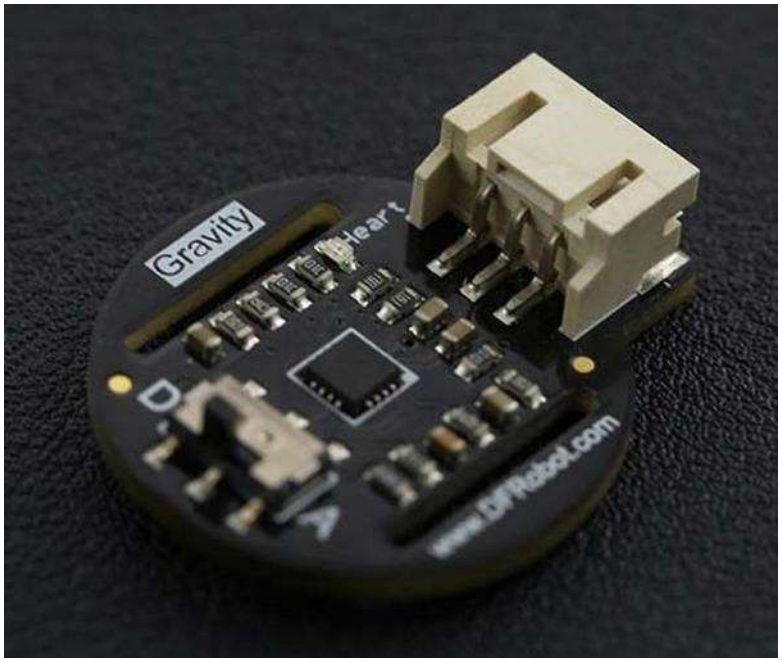
3.4 Display

The function of this screen is to display certain numbers and it has lighting. Among its functions are displaying temperature, heart rate, and others**.**

LCD display 16x2

3.5 Heart Beat Sensor

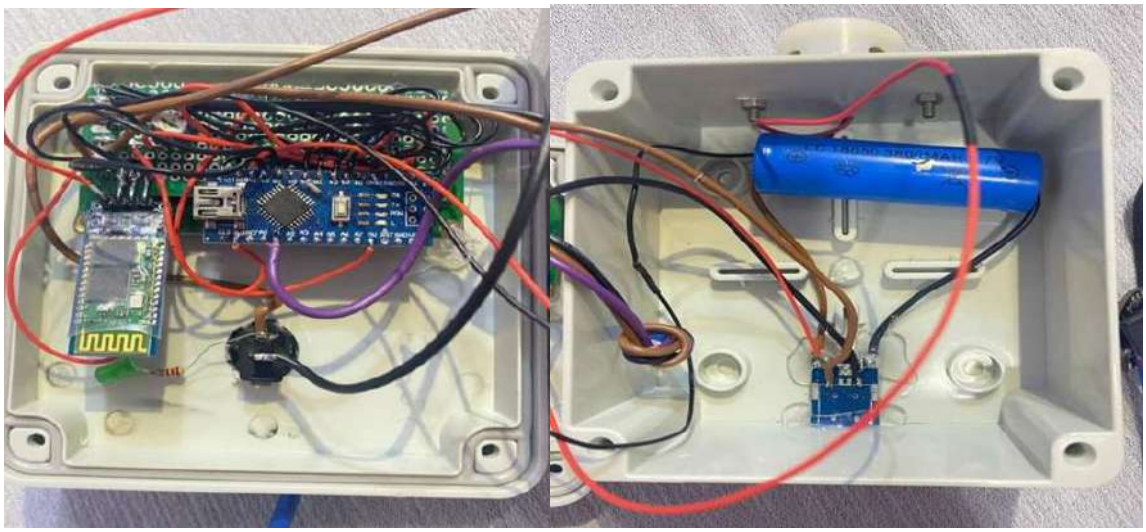
In this project, we employed the SKU SEN0203 DFRobot heart rate sensor. This sensor is a compact device, roughly the size of a thumb, specifically engineered for compatibility with Arduino microcontrollers. It incorporates a Gravity interface, which allows for easy plug-and-play connectivity. Functioning as a pulse sensor, it utilizes techniques based on Photoplethysmography (PPG). PPG is an efficient and economical optical method that measures fluctuations in blood volume within the microvascular bed of tissues. By leveraging this principle, it becomes relatively easy to detect the pulsatile aspect of the cardiac cycle. The sensor is designed with two attachment holes for securing it to a belt and can be affixed to a finger, wrist, earlobe, or any other area of skin contact. It provides two signal output modes: analog pulse mode and digital square wave mode, with the output mode being adjustable through a dial switch.



Heartbeat sensor

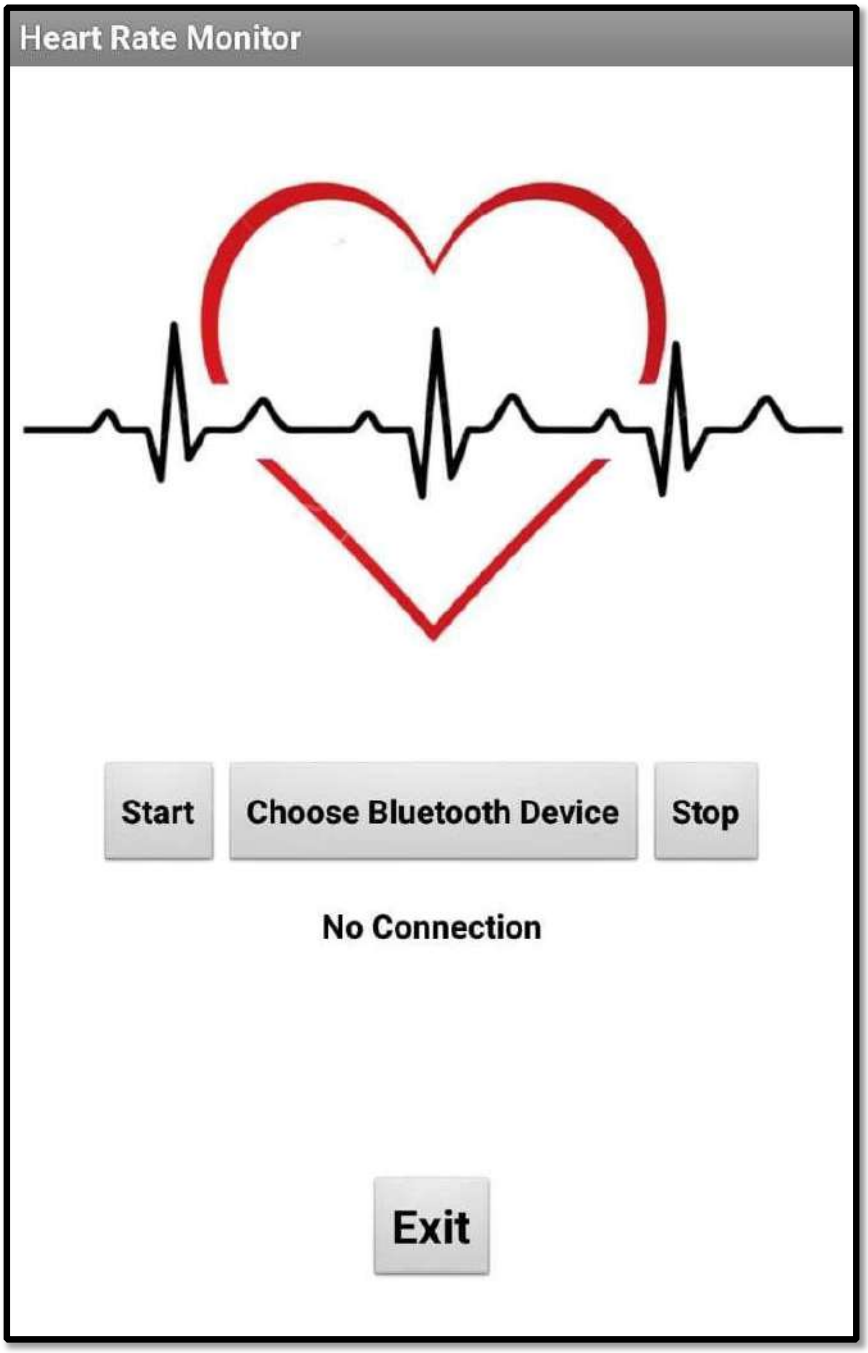
4. Working and Results

Upon activation of the power supply, the green LED on the device illuminates, signifying that the circuit is functioning correctly. This system incorporates a heartbeat sensor that measures the heart rate, which is then presented on the LCD screen. The collected data is transmitted via Bluetooth to a mobile phone, where a specially programmed Android application allows users to access and view the heart rate information.



Internal components of the device

The device While working



A screenshot for the mobile application

5. Conclusion

This project involves the examination of a wireless patient health monitoring system designed to track human heartbeats through Bluetooth technology. The measurement of the heartbeat was accomplished using a photodiode in conjunction with a bright LED. The data was processed using an Arduino Uno and transmitted wirelessly to a remote location via a Bluetooth module. The choice of wireless communication was made due to its advantages in providing enhanced mobility for the sensor equipment and lowering costs, particularly in scenarios with multiple transmitting sections.

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