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ORIGINAL CONTRIBUTION

HEART RATE MONITORING SYSTEM USING IOT

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ABSTRACT

A vital component of healthcare, heartbeat monitoring is important for both identifying and treating cardiovascular disorders. Technology has led to the emergence of several heart rate monitoring techniques, from conventional electrocardiograms (ECGs) to contemporary wearable. This essay examines the importance of heartbeat monitoring, the methods used, the applications that are now being used in clinical and individual health, and the potential future developments in this area.

KEYWORDS: IoT, ECG, PPG, ICG, HRV

1. INTRODUCTION

An essential organ in the human body, the heart is in charge of blood and oxygen circulation, the body's normal operation, and overall health maintenance. The heart's chambers contract rhythmically in response to signals from the Sinoatrial (SA) node, producing heartbeats, which are essential for life to continue. Nonetheless, health problems related to one's heart are a major reason for killing people every year around the globe. In case of India, heart diseases are particularly worrying, with tens of thousands of cardiovascular disease-related deaths being registered annually. The increasing demand of the health sector implies that the time has arrived for efficient, continual health monitoring systems to minimize risks associated with health and to cut short the response times in emergency situations.

To deal with the above issues, our paper presents an IOT-based system for tracking the heart rate of a patient and provides the solution of medical dependence on hospital visits and treatment in time. The hacker said it was possible to monitor vital health parameters, e.g., heart rate, and send real-time data to doctors via either mobile devices or computers by means of advanced IOT and wireless sensor technologies. This method improves not only the convenience of continuous monitoring but also allows the physicians to quickly make informed decisions and access patient data regardless of the place and time. Using low-cost, technically mature components such as Arduino and Raspberry Pi, the suggested system can make a patient or elderly person in need of mobility a quote in a home environment. This invention introduces the IOT trend with a fairly pronounced impact on healthcare, whereby it has become the way the x-ray is taken today and a technique for analyzing heart firmness is realized, telling him early enough that he is developing a condition and then initiating preventive care to put efforts also on the efficient management of such conditions.

1.1 TABLE 1

AGE	AVG HEART RATE
NEWBORN	110-170 BPM
5-7 YEARS	85-150 BPM
10-12 YEARS	70-130 BPM
ADULT	60-120 BPM
ATHLETE	60-100 BPM

2. METHODS FOR TRACKING HEART RATE

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2.1 ELECTROCARDIOGRAPHY (ECG):

For cardiac monitoring, electrocardiography is still the gold standard. An ECG captures the heart's electrical activity over time by applying electrodes to the skin. The waveform that is produced gives information on electrical conduction, rhythm, and heart rate. Traditional ECG s must be administered by a physician, although portable ECG equipment is becoming more and more accessible for use at home [1].

2.2 PHOTOPLETHYSMOGRAPHY (PPG):

PPG is a non-invasive method that measures variations in blood volume in micro vascular tissue using light. Wearable technology, such as fitness trackers and smart watches, frequently uses this technique. PPG sensors enable for real-time heart rate monitoring by emitting light and measuring how much of it is absorbed by the blood.

2.3 IMPEDANCE CARDIOGRAPHY (ICG):

This technique estimates cardiac output and blood flow by measuring the electrical impedance of the thorax. Impedance Cardiography provides a continuous, non-invasive way to evaluate heart function, even though it is less popular than ECG and PPG, especially in clinical settings.

2.4 HEART RATE VARIABILITY (HRV):

The differences in the intervals of time between successive heartbeats are examined by HRV analysis. It offers information on the functioning of the autonomic nervous system and general cardiovascular health. HRV is being used more and more in clinical and fitness applications, and it can be evaluated using ECG or PPG data [2].

3. HEARTBEAT MONITORING APPLICATIONS

3.1 MEDICAL DIAGNOSTICS:

For the diagnosis of myocardial infarctions, arrhythmias, and other cardiovascular conditions, heartbeat monitoring is essential. By enabling prompt responses, ongoing monitoring may lower rates of morbidity and death.

3.2 ONLINE MEDICAL SERVICES:

The growth of telemedicine has made it easier for medical professionals to monitor patients remotely and track their heart rates in real time. This method enhances patient outcomes, especially for patients who need ongoing care due to chronic illnesses.

3.3 WELL-BEING AND EXERCISE:

Wearable technology with PPG sensors enables users to monitor their heart rates while exercising. With the use of this data, users may control their stress levels, maximize their workouts, and preserve their general health.

3.4 PUBLIC HEALTH AND RESEARCH:

Researchers can better understand population health trends and the influence of lifestyle factors on cardiovascular health by using heartbeat tracking in epidemiological studies.

4. ADVANCEMENTS IN HEARTBEAT MONITORING

4.1 BETTER WEARABLE TECHNOLOGY:

We may anticipate the creation of increasingly complex wearable’s with numerous sensor integration as technology develops. Comprehensive health data, such as heart rate, oxygen saturation, and stress levels, may be provided by these devices [3].

4.2 THE UTILIZATION OF AI AND MACHINE LEARNING:

The accuracy of data interpretation in heartbeat monitoring can be improved by integrating AI and machine learning. Algorithms can spot trends that could point to possible health problems, enabling earlier action [4].

4.3 CUSTOMIZED HEALTH CARE:

Future heartbeat monitoring may concentrate on specialized methods for cardiovascular health due to the growing availability of personalized health data. This could involve food advice and exercise plans that are specifically tailored to each person's heart rate patterns.

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4.4 INTERNET OF THINGS INTEGRATION:

Heartbeat monitoring could undergo a revolution because to the Internet of Things, which makes it possible for gadgets and healthcare providers to share data easily. Remote therapies and in-the-moment health assessments can be made easier by this connectivity.

5. SYSTEM DESIGN

The system can be described in two halves: one is hardware and another one is software.

5.1 HARDWARE

MICROCONTROLLER:

NodeMCU is a Lua based open source firmware and development board that is designed for IoT applications. It is a firmware that is compatible with the ESP8266 Wi-Fi SoC developed by Espressif Systems, as well as a hardware that is built on the ESP-12 module.

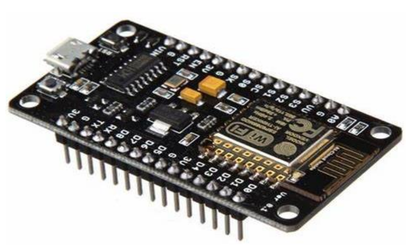

Figure 5.1: ESP 8266

PULSE OXIMETER

The MAX30100 sensor functions as a heart rate monitor and a pulse oximeter. This is achieved by the sensor's design, which comprises two LEDs, a photo detector, optimized optics, and low noise signal processing elements. It is very convenient to be interfaced with microcontrollers like Arduino, ESP32, Node MCU etc. to make a skilled tool for the Heartbeat and oxygen saturation check.

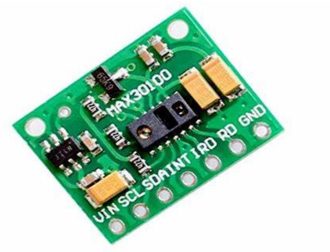

Figure 5.2: MAX30100

LCD DISPLAY

LCD is one of the most prevalent electronic display modules employed in a vast number of applications such as different circuits & devices like mobile phones, calculators, computers etc. Mostly these displays are preferred multi-segment LEDs and seven segments.
There are a number of benefits of the LCD display module which include the following: being very cheap, simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

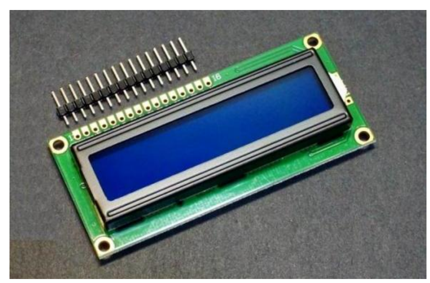

Figure 5.3: LCD Display

5.2 SOFTWARE

BLYNK APP:

Blynk is an enabling platform that enables you to develop mobile applications for Arduino or your PC like Raspberry Pi using your smartphone. To accomplish this goal, the designers of Blynk made ease of the app development the top priority. Thus, the code can be made with just a few touches, which can enable the clients to add widgets and carry out the obtained data, making the client interact with the connected device. Therefore, you can control the likes of your device's LEDs or engines, communicate with sensors placed in numerous locations—like soil moisture monitoring in a garden—and run programs such as irrigation by simply using your cellphone.

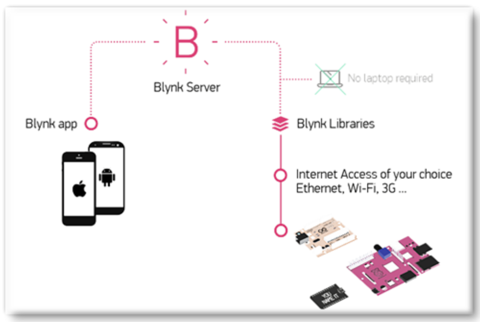

Figure 5.4: Representation of from where data is sent and received

ARDUINO IDE:

The Arduino IDE is a development platform mainly designed for programming motherboards such as the NodeMCU. It enables developers to write, compile, and set microcontroller variations to their boards using the software.

Types of the Arduino IDE features that will be included in this paper are:

Code Development: The Arduino IDE is the best place to get the C code to regulate the heart rate sensor as well as the display modules in the monitoring system.

Libraries: This project demands the use of libraries such as BlynkSimpleEsp8266.h, MAX30100_PulseOximeter.h, and LiquidCrystal_I2C.h, all of which can be integrated with the Blynk platform, data acquisition from the MAX30100 in the heart rate sensor, and the display of results on the LCD.

Serial Monitor: The Serial Monitor of IDE in this case is a tool used for debugging that helps display accurate sensor readings such as BPM and SpO2 from the MAX30100 sensor. This gives a guarantee that sensor data are properly calibrated before they are sent to the Blynk app and presented on the LCD.

6. BLOCK DIAGRAM

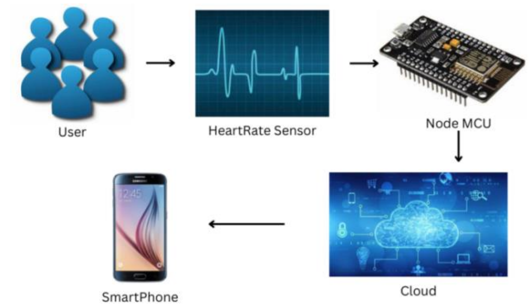

Figure 6.1: Block Diagram

7. CIRCUIT DIAGRAM

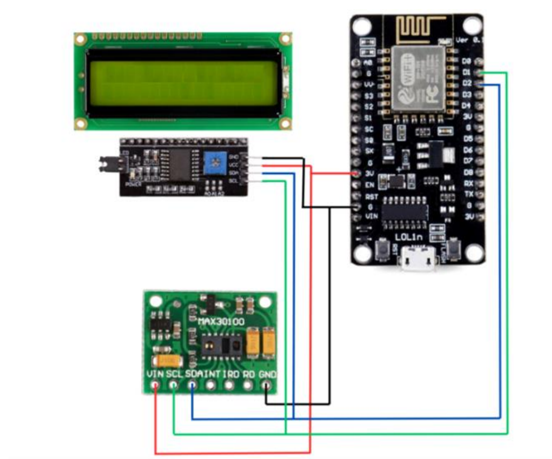

Figure 7.1: Circuit Diagram

8. RESULTS AND ANALYSIS

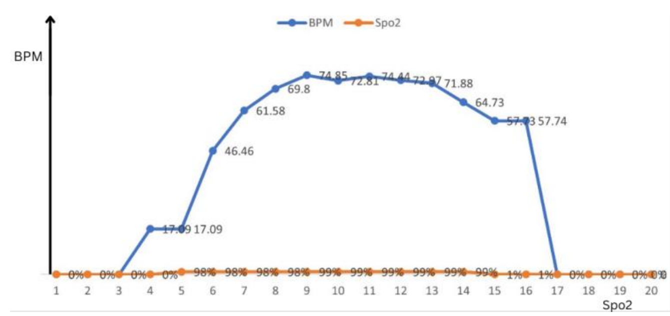

Figure 8.1: Representation of heart rate(BPM) and oxygen saturation (SpO2)

The graph provides a representation of heart rate (BPM) and oxygen saturation (SpO2) values collected during a monitoring session.

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- The BPM values exhibit a bell-curve trend, rising gradually to a peak (around 74–75 BPM) and then declining.
- Outliers, such as low values at the start (17.09) and at the end (0 BPM), indicate potential sensor initialization issues or measurement noise.
- The heart rate values primarily align with normal resting levels (60–100 BPM), indicating stable physiological conditions for the majority of the session.
- SpO2 values remain stable and consistently high (98–99%), confirming normal oxygen saturation levels.
- Minor dips (e.g., 96%) do not deviate significantly, reinforcing the reliability of the sensor.

9. OBSERVATIONS

1) The heart rate readings exhibit noticeable fluctuations, with stable periods observed in the range of 64–77 BPM, indicating the normal resting or mildly active state of the subject.
2) The MAX30100 sensor performed well in detecting heart rate and SpO2 levels during stable conditions.
3) SpO2 values remained predominantly stable at 98–99%, demonstrating reliable oxygen saturation monitoring throughout the test session.
4) The gradual bell-curve trend of heart rate values suggests a correlation with normal physiological variations during the monitoring period.
5)
6) Peaks in heart rate readings (around 74–77 BPM) and subsequent drops indicate changes in the subject's activity or rest state.
7) The system is well-suited for continuous heart rate monitoring in stable environments but may require further optimization for dynamic or ambulatory conditions.

10. CONCLUSION

Overall Stability:

- The heart rate values are generally within a typical range, assuming the person is at rest or in a low-activity state.
- Confidence levels of 100% during events confirm the reliability of these measurements.

Sensor Artifacts:

- Outlier values (e.g., 7.51 bpm, 42 bpm) and reduced confidence percentages might reflect sensor noise, poor contact, or motion artifacts. These should be excluded from analysis for accurate interpretation.

Actionable Insights:

- The data is from a heart rate monitoring project
- (e.g., MAX30100), must ensure proper calibration and test the setup to reduce artifacts. Additionally, implement a filter to ignore outlier values that are biologically implausible.
- Focus on readings with 100% confidence for further analysis and visualization, as these are likely the most accurate.

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