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| **IoT Heart Rate Monitoring System** | |  |
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**Abstract:**

These days we have an increased number of heart diseases including increased risk of heart attacks. Our proposed system users sensors that allow to detect heart rate of a person using heartbeat sensing even if the person is at home. The sensor is then interfaced to a microcontroller that allows checking heart rate readings and transmitting them over internet. The user may set the high as well as low levels of heart beat limit. After setting these limits, the system starts monitoring and as soon as patient heart beat goes above a certain limit, the system sends an alert to the controller which then transmits this over the internet and alerts the doctors as well as concerned users. Also, the system alerts for lower heartbeats. Whenever the user logs on for monitoring, the system also displays the live heart rate of the patient. Thus, concerned ones may monitor heart rate as well get an alert of heart attack to the patient immediately from anywhere and the person can be saved on time.

# I. INTRODUCTION

A revolutionary advancement in healthcare technology, the Internet of Things (IoT) heart rate monitoring system represents a paradigm shift in patient care and health management. This innovative system leverages interconnected devices and sensors to continuously monitor and transmit real-time heart rate data from individuals to healthcare providers or personal devices. By seamlessly integrating into everyday life, IoT heart rate monitors offer unparalleled convenience and efficiency in tracking cardiovascular health metrics. The IoT infrastructure allows for remote monitoring, enabling healthcare professionals to access vital signs promptly and respond swiftly to any anomalies or emergencies. This capability not only enhances the quality of care but also facilitates proactive intervention, potentially preventing serious health incidents. Moreover, patients benefit from personalized insights derived from continuous data collection, empowering them to make informed decisions about their health and wellness. Privacy and security are paramount in IoT healthcare systems, with stringent measures in place to safeguard sensitive patient information and ensure compliance with regulatory standards. As the IoT ecosystem continues to evolve, advancements in sensor technology and data analytics promise further improvements in accuracy, reliability, and usability of heart rate monitoring systems. In conclusion, the IoT heart rate monitoring system exemplifies the transformative potential of technology in healthcare, offering unprecedented levels of connectivity, precision, and patient- centric care. Embracing these innovations holds the promise of revolutionizing how we manage cardiovascular health, ultimately leading to better outcomes and enhanced quality of life for individuals worldwide.

# II. LITERATURE SURVEY

A microcontroller based automatic heart rate counting system from fingertip Mamun AL, Ahmed N, ALQahtani (JATIT)Journal OF Theory and Applied technology ISSN 1992-8645: In this research paper heart-rate signals were collected from finger or ears using IRTX-RX (Infrared Transmitter and Receiver pair) module which was amplified in order to convert them to an observable scale. A low pass filter was used to filter inherent noise. These signals were counted by a microcontroller module (ATmega8L) and displayed on the LCD. Microcontroller is programmed with an algorithm to run the proposed heart rate counting system. The results obtained using this process when compared to those obtained from the manual test involving counting of heart rate was found satisfactory. The proposed system is applicable for family, hospital, community medical treatment, sports healthcare and other medical purposes. Also, fit for the adults and the paediatrics. However, this method in the developed system needs further investigation and need more functionality, which may be useful to consider advance in future research .Heart beat Sensing and Heart Attack Detection Using internet of things: IOT Aboobacker sidheeque, Arith Kumar, K. Sathish,(IJESCE) International Journal Of Engineering Science and Computing, April 2007 : In this research paper implementation of heartbeat monitoring and Heart attack detection system using Internet of things is shown. These days we saw increased number of heart disease and heart attack. The sensor is interfaced to a microcontroller that allows checking heart rate readings ad transmitting them over internet. The user may Set the level of heart beat limit. After setting these limits, the system starts monitoring and as soon as patient heart beat goes above a

certain limit, the system sends an alert to the controller which then transmits this over the internet and alerts the doctors as well as concerned users. Also, the system alerts for lower heartbeats. Whenever the user logs on for monitoring, the system also displays the live heart rate of the patient. Thus, concerned patients may monitor heart rate as well get an alert of heart attack to the patient immediately from anywhere and the person can be saved on time.

A Heartbeat and Temperature Measuring System for Remote

Health Monitoring using Wireless Body Area Network Mohammad Wajih Alam, Tanin Sultana and Mohammad

Sami Alam International Journal of Bio Science and BioTechnology Vol.8, No.1 (2016): In this research paper, the

design and development of a

microcontroller-based heartbeat and body

temperature monitor using fingertip and temperature sensor is shown. The device involves use of optical technology to detect the flow of blood through the finger and offers the advantage of portability over conventional recording systems. Wireless body area network based remote patient monitoring systems have been presented with numerous problems including efficient data extraction and dynamic tuning of data to preserve the quality of data transmission. Evaluation of the device on real signals shows accuracy in heartbeat measurement, even under intense physical activity. This paper presents these challenges as well as solution to these problems by proposing an architecture which allows a network to be formed between the patient and doctor in order to enable remote monitoring of patient by analysing the data of patient. The device consists of sensors which are used to measure heartbeat as well as body temperature of a patient and it is controlled by a central unit. The readings from these sensors are further processed and sent via GSM module to a remote location where it is displayed on cell phone. The optical heartbeat sensor counts the heartbeat per minute and Temperature sensor measures the temperature from the body and both the measured data are sent to a receiving end utilizing wireless technology where the data is displayed in a

cell phone for further processing and patient care. This device is shown superior in comparison to traditional systems.

# III. PROBLEM STATEMENT

Reliability and Accuracy: Ensuring the sensors and devices used in IoT heart rate monitoring systems provide consistently accurate readings is crucial. Variations in sensor quality or placement can lead to unreliable data, potentially compromising patient care and decision- making.

Data Security and Privacy: IoT devices collect sensitive health data continuously. Protecting this information from unauthorized access, breaches, or misuse is paramount to maintain patient trust and comply with regulatory requirements such as HIPAA (Health Insurance Portability and Accountability Act).

Interoperability: Integrating IoT devices with existing healthcare systems and electronic health records (EHRs) poses interoperability challenges. Ensuring seamless data exchange between different platforms and devices is essential for comprehensive patient care and data continuity.

Scalability: As IoT heart rate monitoring systems expand to accommodate more patients and healthcare facilities, scalability becomes a significant concern. Systems must handle increasing data volumes efficiently while maintaining performance and reliability.

User Adoption and Usability: Patient and healthcare provider acceptance of IoT heart rate monitoring systems depends on ease of use, intuitive interfaces, and clear benefits over traditional monitoring methods. Ensuring usability for diverse user groups is critical for widespread adoption.

Regulatory Compliance: Adhering to regulatory standards and certifications applicable to medical devices and data handling (e.g., FDA regulations) is essential to ensure safety,

efficacy, and legality of IoT heart rate monitoring systems

# IV. EXISTING SYSTEM

The existing system for heart rate monitoring may involve traditional methods like manual monitoring using pulse oximeters or more advanced solutions like wearable fitness trackers with heart rate monitoring capabilities. These systems typically require users to take proactive steps to monitor their heart rate periodically. With the introduction of IoT technology, the existing system can be enhanced by enabling continuous, real-time monitoring of heart rate data. IoT devices can collect and transmit heart rate data wirelessly to a centralized monitoring system, providing users with instant feedback and alerts based on their heart rate patterns. By integrating IoT technology into the existing system, users can benefit from more convenient and efficient heart rate monitoring, leading to improved health management and early detection of potential heart-related issues

# V. PROPOSED SYSYTEM

In the proposed IoT heart rate monitoring system, we aim to leverage the power of Internet of Things technology to revolutionize how users track and manage their heart health. The system will consist of wearable heart rate monitoring devices that continuously collect real-time heart rate data. This data will be transmitted wirelessly to a central monitoring platform, where it will be analyzed to provide users with valuable insights into their heart health. The proposed system will offer features such as personalized heart rate tracking, real-time alerts for abnormal heart rate patterns, historical data analysis for trend identification, and integration with smartphone apps for easy access to health information. Additionally, the system will prioritize user privacy and data security by implementing robust encryption protocols to safeguard sensitive health information. By implementing this advanced IoT heart rate monitoring system, users will have access to a comprehensive and proactive approach to managing their heart health, empowering them to make informed

decisions and take actions

**VI. HARDWARE AND SOFTWARE REQUIREMENTS HARDWARE REQUIREMENTS:**

1. Node MCU ESP 8266
2. MAX30100 pulse oximeter Module
3. 0.96 OLED Display Breadboard
4. Jumper wires
5. 4.7K Resistors

**SOFTWARE REQUIREMENTS:**

1. Signal Acquisition Software
2. Data Processing Software
3. Data Storage and Management
4. User Interface Software
5. Data Analysis Software
6. Communication Software
7. Notification System
8. Power Management
9. Software Security and Privacy Software
10. Integration APIs

# VII. MODULES

A heart rate monitoring system typically consists of several key modules that work together to accurately measure and report heart rate data. Here’s a breakdown of the main modules:

Sensor Module:

Photoplethysmography (PPG): Uses light to detect blood volume changes in microvascular tissues.

Electrocardiogram (ECG): Measures electrical activity of the heart using electrodes. Chest Strap/Optical Sensors: Depending on the method, can be worn on the body or used in handheld devices Signal Processing Module:

Analog-to-Digital Converter (ADC): Converts analog signals from the sensor into digital data.

Filtering: Removes noise from the signal to improve accuracy (e.g., band-pass filters). Feature Extraction: Identifies key features like R-peaks in ECG or pulse intervals in PPG. Data Analysis Module:

Heart Rate Calculation: Computes heart rate from the processed signals.

Arrhythmia Detection: Analyzes patterns to identify irregular heartbeats.

Display Module:

User Interface: Displays heart rate readings, trends, and other relevant data (e.g., on a smartphone app or dedicated device). Alerts/Notifications: Sends alerts for abnormal heart rates or arrhythmias. Storage Module:

Data Logging: Stores historical heart rate data for long-term tracking and analysis.

Cloud Integration: Optionally uploads data for remote access or analysis.

Communication Module:

Bluetooth/Wi-Fi: Enables data transfer to other devices, such as smartphones or computers.

API: Allows third-party applications to access heart rate data. Power Management Module:

Battery Management: Ensures efficient power use for wearable devices.

Charging Circuitry: Manages charging for rechargeable devices.

**VIII SAMPLE CODE:**

Sensor Module Photoplethysmography (PPG)

Components: LEDs (usually red and infrared) and a photodetector. Implementation:

Position the LEDs and photodetector on a finger or wrist. Use light absorption principles to measure blood flow changes. Electrocardiogram (ECG)

Components: Electrodes (usually three or more).

Implementation:

Attach electrodes to the skin (e.g., chest, arms). Use an operational amplifier to enhance the small voltage signals from the heart.

2. Signal Processing Module Analog-to-Digital Converter

(ADC)

Implementation:

Use a microcontroller with built-in ADC or an external ADC chip.

Sample the analog signals from the sensor at an appropriate frequency (e.g., 250 Hz for ECG). Filtering

Arrhythmia Detection Implementation:

Use algorithms to analyze intervals and detect irregular patterns. Implement machine learning techniques for advanced detection. 4. Display Module User Interface

Implementation:

Develop a mobile app or use an LCD display.

Use frameworks like React Native for mobile or Arduino

libraries for embedded systems. Alerts/Notifications

Implementation:

Use thresholds to trigger alerts (e.g., HR above 100 BPM). #include <Wire.h>

#include "MAX30100\_PulseOximeter.h" #define

BLYNK\_PRINT Serial

#include <Blynk.h> #include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h> #include

"Adafruit\_GFX.h" #include "OakOLED.h"

#define REPORTING\_PERIOD\_MS 1000

OakOLED oled;

# IX. OUTPUT SCREENS



# X . PROJECT DEPLOYMENT

REQUIRED LANGUAGES:

Embedded C is a programming language commonly used for developing firmware for microcontrollers in embedded systems. When implementing a heart rate monitoring system with the Blynk app, Embedded C is crucial

Installing Dependencies:

Blynk Library:

Enables communication between the microcontroller and the

Blynk app. Provides functions for sending and receiving data.

Sensor Libraries:

Heart Rate Sensor Libraries: For specific sensors like PPG or ECG. Example: Libraries for MAX30100, MAX30102 (PPG sensors).

Handle sensor initialization, data reading, and signal processing.

Wi-Fi or Ethernet Libraries:

For microcontrollers with networking capabilities (e.g., ESP8266, ESP32). Example: ESP8266WiFi.h or WiFi.h for ESP32.

ADC (Analog to Digital Converter) Library:

If using analog sensors, a library or functions to read ADC values may be required. Most microcontroller environments provide built-in ADC functions.

RTOS (optional):

If the application requires multitasking, consider using a realtime operating system. Examples: FreeRTOS, which can help manage tasks more efficiently.

Math Libraries:

For any complex calculations, especially in signal processing. Standard math libraries typically included in Embedded C environments.

Loading the Code:

Write Code: Open Arduino IDE, write or paste your Arduino sketch in the editor.

Select Board: Go to Tools > Board and select the appropriate Arduino board you are using. Select Port: Connect your board via USB, then select the correct port under Tools > Port. Upload Code: Click the upload button (right arrow icon) in the IDE to compile and upload the code to your board.

Monitor Output: Use the Serial Monitor (found in Tools > Serial Monitor) to view any output or debug messages from your code.

Running the Code:

Click the checkmark icon (✓) to verify or compile your code. This step checks for errors and ensures the code is syntactically correct. Upload the Code:

Click the upload button (right arrow icon) to upload the compiled code to the Arduino board. The IDE will display a progress bar and status messages.

Use the Serial Monitor (Optional):

Open the Serial Monitor (Tools > Serial Monitor) to view output from your sketch, such as debugging information or data sent via Serial.print().

Interacting with the System: Interacting with blynk app Set Up the Blynk App:

Download the Blynk app from the App Store or Google Play. Create a new project, select your device type (e.g., Arduino, ESP8266), and choose the connection type (Wi-Fi, Ethernet, etc.).

Once the project is created, note the Auth Token sent to your email, as you will need it in your code. Create a User Interface:

Add widgets to your Blynk project (e.g., Gauge, Value Display) to visualize heart rate data. Assign virtual pins (e.g., V0 for heart rate) to the widgets you add, which will be used in your code.

Code Your Hardware:

Use the Blynk library in your Arduino sketch. Here’s a basic outline: Include necessary libraries (e.g., Blynk, sensor libraries).

Initialize Blynk with the Auth Token. Set up Wi-Fi connection.

In the loop, read heart rate data from the sensor and send it to

Blynk using Blynk.virtualWrite().

# XI.INTEGRATION AND EXPERIMEMTAL RESULTS

Integration Strategies

1.Sensor Integration: IoT devices often incorporate sensors (like photoplethysmography or PPG) to measure heart rate non-invasively. These sensors detect blood volume changes in microvasculature, providing real-time heart rate data.

2.Data Transmission: Data from IoT heart rate monitors is typically transmitted wirelessly (e.g., via Bluetooth, Wi-Fi, or cellular networks) to cloud platforms or local servers for storage and analysis.

3.Cloud Computing: Cloud platforms store and process large volumes of data generated by IoT devices. They enable realtime monitoring, data analytics, and integration with other health information systems.

4.Data Security: Given the sensitive nature of health data, encryption protocols and secure communication channels are crucial to protect patient privacy and comply with healthcare regulations (e.g., GDPR, HIPAA).

5.User Interfaces: Integration often involves developing userfriendly interfaces (mobile apps or web portals) for patients, caregivers, and healthcare professionals to access and interpret heart rate data.

Experimental Results

1.Accuracy: Studies have shown that IoT heart rate monitors can achieve accuracy comparable to traditional medical devices. However, accuracy may vary depending on factors like sensor placement and patient movement.

2.Real-time Monitoring: IoT systems enable continuous, realtime heart rate monitoring, allowing for early detection of abnormalities or changes in heart rate patterns.

3.Long-term Monitoring: Unlike traditional monitoring methods limited to clinical settings, IoT devices facilitate long-term monitoring in natural environments (e.g., home or workplace), providing a more comprehensive view of heart health.

4.Health Insights: Analysing continuous heart rate data can reveal insights into overall cardiovascular health, stress levels, and physical activity patterns over time.

5.Patient Engagement: IoT devices promote patient engagement by empowering individuals to monitor their own health metrics actively. This can lead to better adherence to treatment plans and lifestyle modifications..

# XII . FUTURE ENHANCEMENTS

Enhanced Accuracy

Advanced Sensors: Development of more precise optical and electrical sensors to improve heart rate measurement accuracy.

Multi-parameter Monitoring: Integration of additional physiological parameters (e.g., blood oxygen levels, temperature) for a comprehensive health assessment.

Artificial Intelligence Integration

Predictive Analytics: Using AI algorithms to analyze heart rate trends and predict potential health issues or irregularities. Personalized Recommendations: Tailoring health advice and lifestyle changes based on individual heart rate data patterns.

Improved Data Security

End-to-End Encryption: Implementing stronger security protocols to protect sensitive health data from breaches. User Control Over Data: Enhancing user interfaces to allow individuals more control over data sharing and permissions.

Extended Battery Life

Energy-Efficient Technologies: Utilizing low-power components and energy-harvesting technologies to extend the operational lifespan of devices.

Dynamic Power Management: Implementing smart power management systems that adapt based on usage patterns.

Seamless Integration

Interoperability with Other Devices: Ensuring compatibility with a broader range of health devices (like glucose monitors or sleep trackers) for a holistic view of health.

Integration with Healthcare Systems: Facilitating direct data sharing with healthcare providers for timely monitoring and intervention.

User Engagement Features

Gamification: Introducing reward systems for achieving health goals to encourage consistent usage and engagement. Social Sharing: Enabling users to share their progress with friends or health communities to boost motivation.

Wearable Comfort and Design

Ergonomic Designs: Developing more comfortable and stylish wearables that users are likely to wear consistently.

Flexible Materials: Exploring the use of flexible and breathable materials for improved comfort during prolonged wear.

Remote Monitoring Capabilities

Telehealth Integration: Enhancing capabilities for healthcare providers to monitor patients remotely, facilitating timely interventions for at-risk individuals.

Alerts for Caregivers: Implementing real-time alerts for caregivers or family members when abnormal heart rate readings are detected.

User Education and Support

Guided Tutorials: Offering in-app tutorials on how to interpret heart rate data and understand its implications for health.

Health Coaching Services: Providing access to health coaches or professionals through the app for personalized guidance.

Research and Development

Clinical Trials: Encouraging participation in research studies to validate the effectiveness of new technologies and methods in heart rate monitoring.

Feedback Loops: Establishing channels for user feedback to continuously improve product features and user experience.

# XIII. CONCLUSION

In conclusion, the Blynk app presents a convenient and customizable solution for heart rate monitoring, appealing to users seeking real-time data and enhanced user engagement through features like gamification and community support. However, it may fall short in accuracy, latency, and connectivity compared to established clinical systems that prioritize precision and reliability in medical settings. For users focused on casual health tracking and personal fitness, the Blynk app can be an effective tool. Conversely, those requiring rigorous health monitoring or integration into healthcare systems should consider traditional, clinically validated devices for more dependable results. Ultimately, the choice depends on the user's specific needs, priorities, and context of use. An IoT heart rate monitoring system offers significant advantages for personal health management and remote patient monitoring. By leveraging real-time data collection, cloud storage, and advanced analytics, such systems empower users to track their heart health continuously and gain insights into their overall well-being. The integration of IoT technology enhances connectivity and accessibility, allowing users to receive alerts and monitor trends over time, ultimately promoting proactive health management. However, it’s essential to consider factors like accuracy, data security, and battery life, which can vary between devices.

Overall, IoT heart rate monitoring systems represent a transformative approach to health monitoring, making heart health management more accessible and efficient while facilitating timely interventions when necessary.

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# XIV. REFERENCES

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