HEALTH MONITORING SYSTEM USING ESP8266

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Abstract: -The Internet of Things (IoT) has emerged as a transformative technology that has revolutionized the field of healthcare. One game-changing technology that has completely changed the healthcare industry is the Internet of Things (IoT). Patient health monitoring is one of the most exciting uses of the Internet of Things (IoT) in healthcare. It enables medical professionals to remotely check on patients' health and offer timely care when necessary. The goal of this research project is to create an Internet of Things (IoT)-based patient health monitoring system that will help patients—especially the elderly—who are at risk of dying suddenly from neglecting their medical needs. The suggested system monitors the patient's vital signs using an ESP8266 connected heartbeat sensor and an Infrared IR temperature sensor, respectively. The suggested system monitors the patient's vital signs using an ESP 8266 connected heartbeat sensor and an Infrared IR temperature sensor, respectively. The data is gathered by the sensors and transmitted over a Wi-Fi connection to an Internet of Things (IoT) web platform. Doctors and nurses can monitor the patient's temperature and heart rate in real time using the Internet of Things (IoT) platform. In the event of a medical emergency, the system is intended to notify healthcare professionals so that the patient can receive timely medical attention.

Keywords- Patient health monitoring; Internet of Things (IoT); Nodemcu ESP8266; temperature value; Max 30100; MPU6050;

1. INTRODUCTION

In today's digital world, the use of the Internet has transformed many industries, including healthcare. The rise of Internet of Things (IoT) technology has changed the way we monitor and care for patients. With improved internet access and smarter devices, it is now possible to track a patient's health 24/7 using IoT-based health monitoring systems. These devices collect real-time data, monitor vital signs, and allow remote access to patient information. This not only helps in continuous monitoring but also supports quick emergency responses. Traditional patient monitoring in hospitals is often slow, requires manual checks by medical staff, and can lead to errors. Families must also visit hospitals to get updates, which can be stressful. Many hospitals still use paper records, which are prone to mistakes and missing data. This wastes time and can harm patient care. An IoT-based health monitoring system offers a better solution by enabling remote monitoring, digital record keeping, and quick health updates. This study aims to improve healthcare services by using IoT to overcome current challenges. With features like real-time monitoring, smart data collection, and instant alerts, IoT systems are well-suited for modern healthcare. Even though earlier studies have shown great results, adoption has been slow. This work aims to build a more reliable, updated, and innovative healthcare system that meets today's needs for saving lives and advancing medical technology. This study contributes to the healthcare field by developing an Internet of Things (IoT)-based patient health monitoring system that allows remote tracking of vital signs and provides quick medical response during emergencies. The system uses heartbeat and temperature sensors connected to an NodeMCU, which send real-time data to an IoT web platform. This platform displays the patient's health status continuously. The proposed system offers a modern, efficient, and effective way to monitor patient health, helping to improve overall healthcare services and leading to better quality of life and health outcomes for society.

1.1 Related Work

In recent years, numerous studies have explored the use of Internet of Things (IoT) technology in healthcare, particularly focusing on remote health monitoring systems. The ESP8266 Wi-Fi module has gained popularity due to its low cost, low power consumption, and ease of integration with sensors and microcontrollers.

Since its inception in the early 2000s, the traditional approach to patient health monitoring has been a mainstay in healthcare facilities like hospitals and clinics. This method has been widely used over the years, but it is not very effective at accurately monitoring a large number of patients in a predetermined amount of time. Physically inspecting and documenting patient data is the responsibility of health personnel, which includes physicians and nurses. For examinations, patients must wait in line, and those who are bedridden need constant supervision. Patient information is meticulously manually entered into a patient booklet and physically kept on a shelf.

Pradhan, Zainuddin, and Sahak conducted a study that explored various methods for monitoring health status using multiple sensors. Their research focused on real-time health monitoring of animals by using sensors to measure temperature, respiration rate, heart rate, and humidity. The system was controlled using a Raspberry Pi with built-in Wi-Fi, and the collected data was transmitted to a cloud-based platform. Additionally, an Android mobile application was developed to display the real-time health data. This study demonstrates the practical use of wearable monitoring devices, which supports the idea of applying similar systems in human health monitoring, as proposed in our research.

A health monitoring system centered on three patient vital signs—temperature, blood pressure, and heartbeat—was proposed by Masud, Muhammad, and Alhumyani . The system gathers and displays the data on a Liquid Crystal Display (LCD) and stores it in cloud-based storage using a microcontroller and multiple sensors. The purpose of this system is to help medical personnel monitor several patients at once. To carry out the project, the authors used microcontrollers like Arduino and Nodemcu. The system has been tested and has demonstrated good accuracy in monitoring patients' vital signs introducing a novel tree-based deep model for automatic face recognition in a cloud-based environment that strikes a balance between computational efficiency and high accuracy. The model divides the input.

V. Akhila, Y. Vasavi, K. Nissie, and P. V. Rao have utilized IoT and sensor technologies to develop a system that can monitor a patient's health condition in real-time [20]. The authors tested the system by monitoring the health condition of a real individual. The project involved the use of Internet of Things (IoT) and microcontroller like Arduino to gather data from analogue sensors. In the healthcare industry, the combination of IoT with Arduino microcontroller has proven to be effective in monitoring and collecting current patient health condition data.This work describes the use of Arduino UNO as a sensor node and gateway in a remote health monitoring system. The system utilizes GSM for communication between doctors and patients, and Wi-Fi for transmitting sensor data to a web-based IoT platform.

1.2 Background

The last few years have witnessed a rapid development of smart-based technologies with an increasing adoption in the field of healthcare monitoring and disease tracking. Intelligent health monitoring systems utilize implanted sensors, microcontrollers, and the cloud framework to monitor and transmit patient information in real time [11]. Monitoring vital signs including heart rate, body temperature, blood oxygen level (SpO_2), and physical activity continuously with these systems can have a significant impact.

Advances in Internets of Things (IoTs) have led to more sophisticated and scalable health monitoring solutions available remotely. These systems prevent premature hospital admissions and are capable of predicting early stages of health deterioration leading to early medical intervention, ultimately minimizing healthcare expenditure. In conventional approaches, there are platforms (such as ThingSpeak) that provide the storage of data and isolation. But today we have more flexible real-time solutions like Firebase which are becoming more and more popular because they are very scalable and much easier to setup with mobile & web apps.

In this project an IOT based patient health monitoring system is designed using MAX30100, LM35 and MPU6050 sensors. MAX30100 sensor is designed to measure Heart Rate; the LM35 sensor will provide body temperature measurements and MPU6050 will provide physical movement and orientation such as fall detection or motion analysis. These sensors are connected to microcontroller (NodeMCU) and the data found is viewed in the serial monitor, and also pushed to Firebase at the same time.

This Web-based solution allows health care providers to remotely view and track patient health data via a real-time dashboard. This technology can have a great impact on the provision of health care, particularly on in underserved or rural areas where medical facilities are scarce. Therefore, the developed system provides a low-cost, scalable, and robust solution for current healthcare monitoring requirements.

2. LITERATURE REVIEW

Some The progressive evolution of the Internet of Things (IoT) has transformed the healthcare by facilitating real-time and non-regularity monitoring. These systems have been gaining popularity, particularly as a result of the COVID-19 pandemic, where an early detection of symptoms such as fever and low oxygen saturation was essential to decrease the number of deaths. Many studies have investigated sensor-integrated systems in combination with IoT for efficient health observation.

Dalvi (2024) designed a health monitoring system with the ESP8266 microcontroller as the main processing unit, LM35 Temperature, and MAX30100 (heart rate and SpO_2 sensor) in order to detect early symptoms of COVID-19, such as high fever and low SpO_2 values. In the same way, Archana (2024) introduced a precise review of IoT-enabled POLY monitors in the healthcare context, concentrating on real-time data detection using flexible and wireless sensors for patient health benefits. The paper classified different sensor technologies, such as body temperature sensor, pulseoximeter sensor, and motion sensor, and compared the performance in terms of data accuracy, data privacy and quality of service (QoS). It also pointed out concerns about privacy, security of data, and integration with current medical infrastructure.

Although they provide a strong foundation for IoMT service for health monitoring, three sensors, namely, MAX30100, LM35, and MPU605 are used jointly in this work to equip independent physiological measurements. Unlike Dalvi’s system that transmits sensor data through a single microcontroller to a common platform, our system utilizes two different data routing methods: Readings from the MAX30100 (heart rate and SpO_2) can be seen on the blynk mobile app allowing convenient patient visualization. Data generated by LM35(temperature) and MPU6050(motion/orientation) sensors is transmitted to Firebase for cloud storage in real time, and so professionals can access it with the help of a custom monitoring dashboard.

3. METHODOLOGY

3.1 REQUIRED EQUIPMENTS

ESP8266 NODE MCU BOARD

MAX30100 SENSOR (FOR BPM AND SPO2)

LM35 SENSOR (FOR TEMPERATURE)

MPU6050 SENSOR (FOR FALL DETECTION)

BREAD BOARD

JUMPING WIRE

3.1 PROPOSED WORK

The proposed health monitoring system is designed to continuously track critical physiological parameters using low-cost sensors integrated with an ESP8266 NodeMCU microcontroller and connected to cloud-based IoT platforms for real-time monitoring and data storage. The system utilizes three primary sensors: the MAX30100 sensor for heart rate (BPM) and blood oxygen saturation (SpO2), the LM35 temperature sensor for body temperature, and the MPU6050 sensor for motion and fall detection.

To optimize the performance and reliability of data acquisition, the sensors are strategically divided based on power and communication constraints. The MAX30100 sensor communicates with the ESP8266 via the I2C interface and transmits heart rate and SpO2 data to the Blynk IoT platform. Blynk is chosen for its ease of integration with the ESP8266 and its ability to provide a user-friendly interface for real-time health data visualization through a mobile app.

However, due to the limited power output and I2C communication bandwidth of the ESP8266, simultaneous operation of all three sensors on a single controller is impractical. Therefore, the LM35 and MPU6050 sensors are designated to send their respective data—temperature and fall detection—to Firebase, a real-time cloud database. This data is then accessed and displayed on a custom-built dashboard, allowing healthcare providers or users to monitor historical and real-time trends in body temperature and movement-related events.

The system is powered by an external regulated power supply to ensure stable voltage for all components. The ESP8266 serves as the central node, managing sensor inputs, processing data, and transmitting it to the appropriate cloud platforms. This architecture ensures that each sensor operates efficiently without overloading the microcontroller, and it provides a scalable and modular approach to remote health monitoring.

By utilizing both Blynk and Firebase, the proposed system achieves real-time visualization and long-term storage of health data. This dual-platform approach enhances system reliability, reduces latency in monitoring, and allows for remote access across different user interfaces. Overall, the proposed work lays the foundation for a cost-effective, IoT-enabled health monitoring system suitable for elderly care, chronic disease management, and home-based healthcare solutions.

3.2 SYSTEM ARCHITEURE

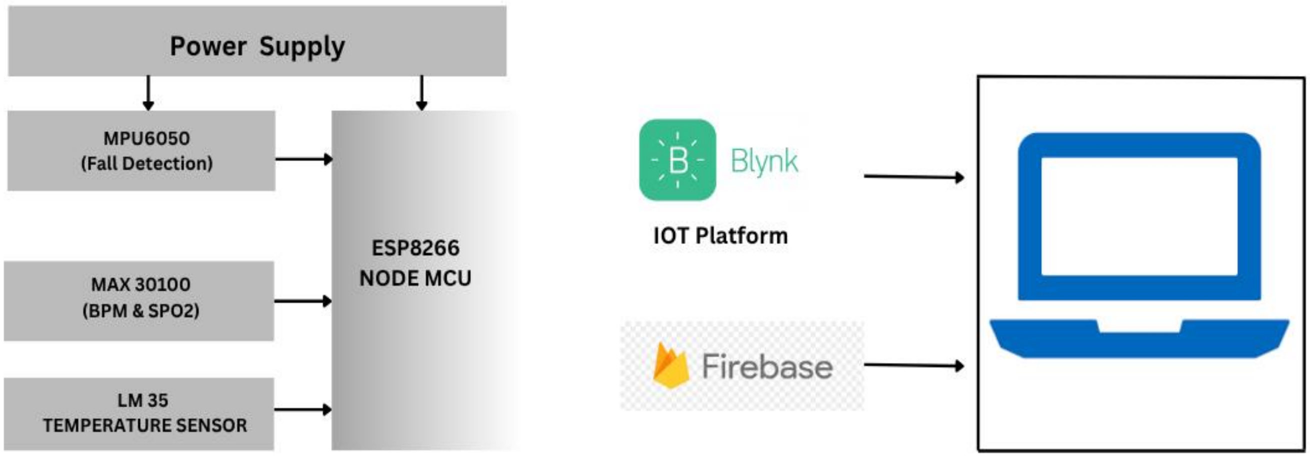

Figure: 1. System Architectural Model

The system architecture for the proposed health monitoring system is centered around the ESP8266 NodeMCU microcontroller, which serves as the core unit for data acquisition, processing, and transmission. The system integrates three biomedical sensors: the MAX30100 sensor for measuring heart rate (BPM) and blood oxygen saturation (SpO2), the LM35 temperature sensor for monitoring body temperature, and the MPU6050 sensor for fall detection using accelerometer and gyroscope data. Each of these sensors communicates with the ESP8266 via I2C or analog interfaces.

Due to power limitations inherent in the ESP8266 when interfacing with multiple I2C devices, the data streams from the sensors are strategically divided across different cloud platforms. The MAX30100 sensor is configured to transmit real-time physiological data to the Blynk IoT platform, which allows end-users to monitor heart rate and oxygen saturation directly from a mobile application. This ensures low-latency feedback and user-friendly visualization.

Simultaneously, the LM35 and MPU6050 sensors send their respective temperature and motion data to the Firebase real-time database. Firebase acts as a scalable cloud storage platform and supports data retrieval to a web-based dashboard, enabling more complex data analysis and visualization. This separation of data streams reduces the load on the ESP8266, minimizes I2C communication conflicts, and conserves power.

A regulated power supply ensures the stable operation of all hardware components. The architectural design supports modular integration, meaning each sensor's data can be independently accessed, monitored, and analyzed through its associated platform. This setup enhances reliability, promotes energy efficiency, and ensures real-time health tracking suitable for applications in remote patient monitoring, elderly care, and emergency alert systems.

4 IMPLEMENTION:

4.1 HARDWARE DEVELOPMENT

The hardware of the proposed health monitoring system is designed using the ESP8266 NodeMCU microcontroller, which features built-in Wi-Fi, making it suitable for Internet of Things (IoT) applications. The system utilizes three sensors: the MAX30100 (for heart rate and SpO2), the LM35 (for body temperature), and the MPU6050 (for fall detection using accelerometer and gyroscope data).

To address power limitations and I2C communication issues with the ESP8266 when multiple I2C sensors are connected simultaneously, the sensors are functionally divided across two platforms. The MAX30100 sensor is connected to the ESP8266 via I2C (SDA and SCL) and transmits its readings (BPM and SpO2) to the Blynk IoT platform for real-time monitoring on mobile devices. The MAX30100 is powered through the VIN and GND pins of the NodeMCU, while its SDA and SCL pins are connected to D2 and D1 of the ESP8266, respectively. The INT pin is left unconnected as it is not required for basic operation.

The LM35 temperature sensor, which provides analog temperature readings, is connected to the A0 pin of the ESP8266. Its VCC and GND are connected to the 3.3V and GND of the NodeMCU, respectively. The MPU6050, an I2C-based sensor for motion and fall detection, shares the same SDA and SCL pins (D2 and D1) with the MAX30100, but due to I2C bus constraints and power issues when all three sensors are used together, only the LM35 and MPU6050 data are transmitted to Firebase, a real-time cloud database. This allows for stable and efficient data storage and retrieval without overwhelming the microcontroller.

The system is powered by a regulated external power supply to ensure consistent voltage delivery, crucial for the stable operation of the ESP8266 and all connected sensors. Each component has been tested individually to verify correct operation. The sensors indicate successful power-up through internal LED indicators or valid data output, confirming functional connectivity.

By distributing the data workload between Blynk and Firebase, the hardware design effectively reduces processing bottlenecks and ensures real-time, reliable health monitoring. This modular setup also allows for future sensor integration or upgrades without significant changes to the core system architecture.

4.2 SOFTWARE DEVELOPMENT

The software development for the proposed health monitoring system focuses on sensor integration, data acquisition, processing, and transmission using the ESP8266 NodeMCU microcontroller. The system is programmed using the Arduino IDE, with required libraries such as Wire.h, Adafruit_MPU6050.h, MAX30100_PulseOximeter.h, FirebaseESP8266.h, and BlynkSimpleEsp8266.h included to support each component.

The MAX30100 sensor is programmed to collect real-time heart rate (BPM) and SpO2 data. These values are transmitted to the Blynk IoT platform via Wi-Fi, allowing for real-time monitoring through a mobile application interface. The Blynk library and authentication token are used to establish secure communication between the ESP8266 and the Blynk cloud, enabling live visualization of pulse data through virtual pins on the app.

The LM35 temperature sensor, which outputs analog voltage, is read through the ESP8266's A0 pin. The voltage is converted to Celsius using a calibration formula and is then uploaded to Firebase Realtime Database. Similarly, the MPU6050 sensor data, which includes acceleration and gyroscopic values, is processed to detect abnormal movement patterns such as sudden falls. When such a fall is detected, a corresponding alert value is sent to Firebase.

Firebase is configured using its project credentials (host and API key), and a secure Wi-Fi connection is initialized in the ESP8266 setup routine. The ESP8266 sends sensor data as JSON objects to specific Firebase paths, which are then accessed by a custom-built dashboard for visualization and analysis. This separation of platforms—Blynk for cardiovascular parameters and Firebase for temperature and motion data—ensures efficient data flow and avoids I2C bus conflicts due to simultaneous sensor polling.

5 PROJECT MODEL

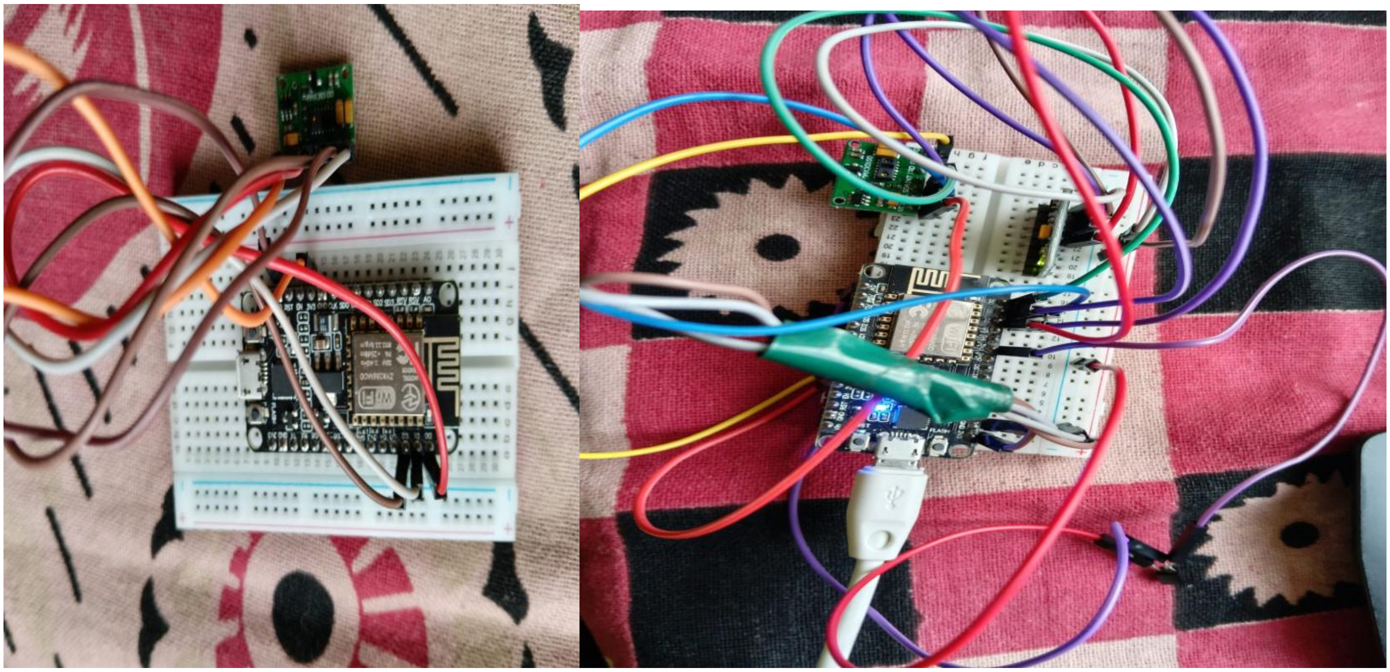

Figure: 2. Project Model

6 RESULTS

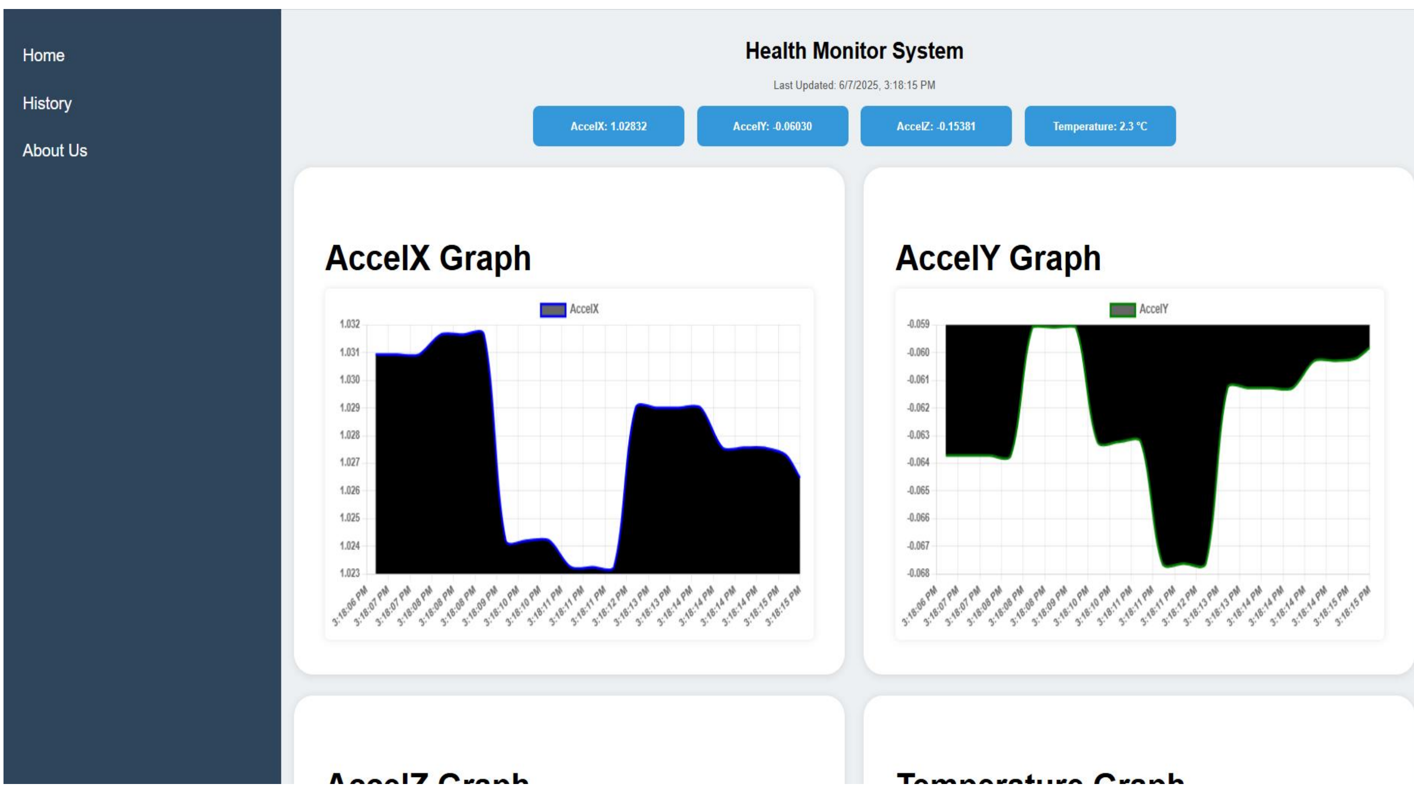

Figure 3. Project Result in Dashboard

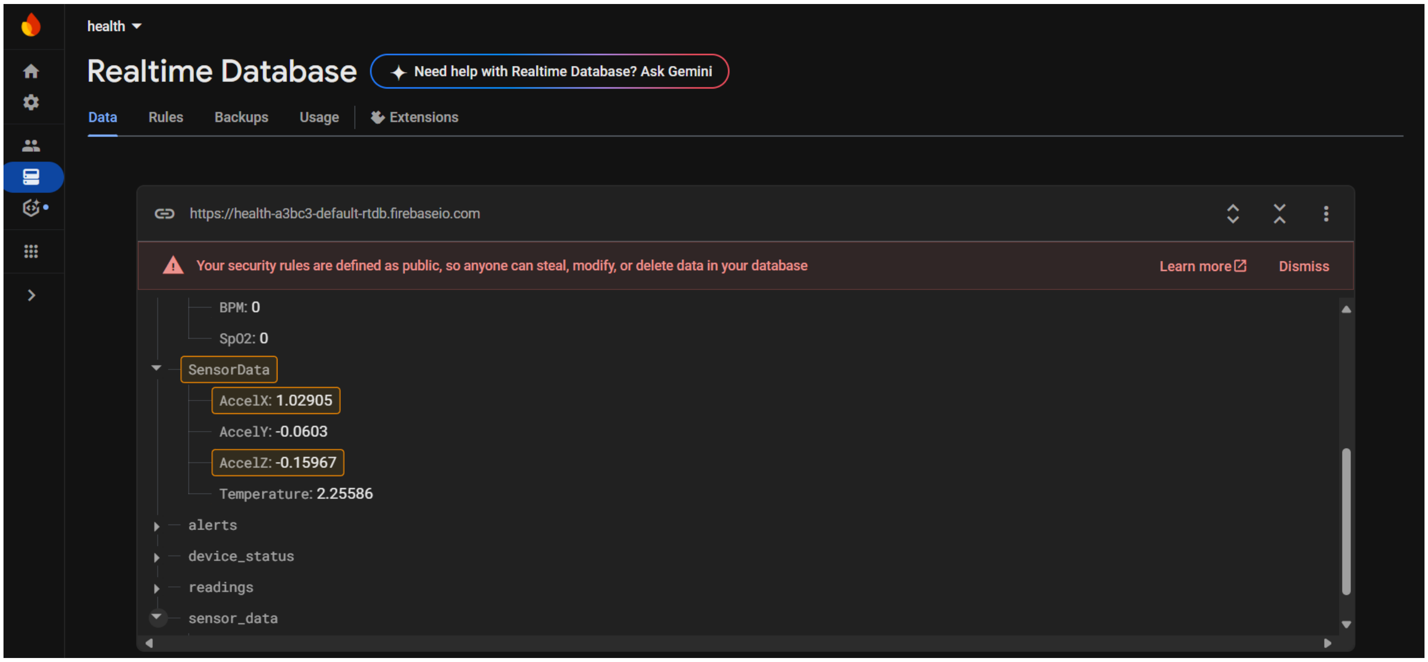

Figure:4. Fetch data in Firebase

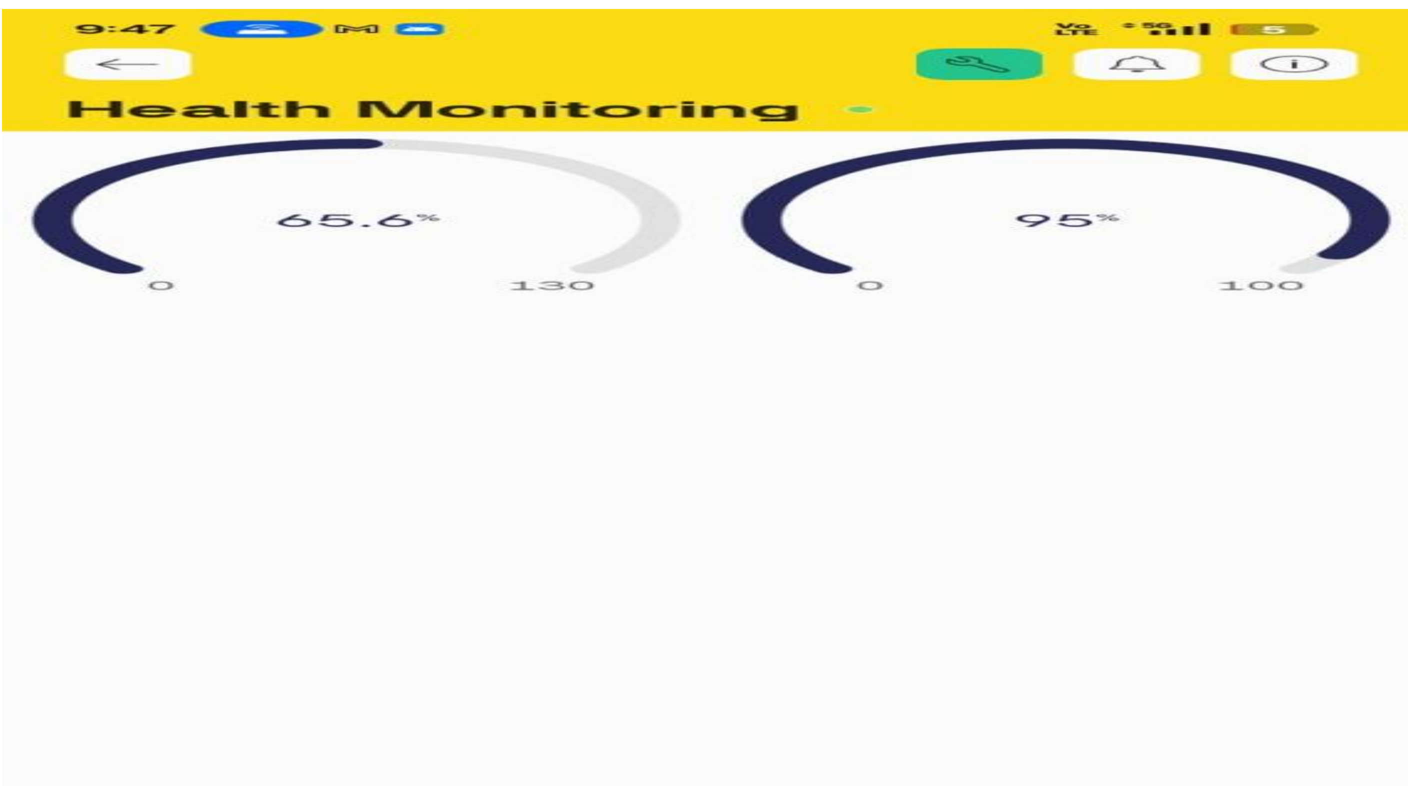

Figure :5. Project Result in Blynk IOT Application

CONCLUSION

In summary, developing a health monitoring system using ESP8266 NodeMCU presents a compelling approach to proactive healthcare management. By harnessing the capabilities of this platform alongside a range of sensors and Wi-Fi connectivity, real-time collection and processing of vital health parameters become feasible. Through robust system architecture and implementation, including secure data handling and efficient communication protocols, the system ensures reliability and accuracy. By delivering timely alerts and notifications, it empowers users and caregivers to respond effectively to any detected anomalies or emergencies. Ultimately, the deployment of such a system holds the potential to revolutionize healthcare by enabling continuous monitoring, early detection of health issues, and personalized interventions, thereby enhancing health outcomes and fostering overall well- being

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