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# Remote Health Monitoring and Diagnosis with Cloud based IOT Framework

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*Abstract*— **IoT-based health monitoring systems are emerging as a promising solution to address the growing healthcare needs of an ageing population. These systems use connected devices to continuously monitor various physiological parameters of individuals and transmit the data to a central server for analysis. This analysis can provide insights into an individual's health status and detect any anomalies that could indicate a potential health issue. The system can also alert healthcare providers in the case of any critical health conditions, enabling prompt interventions. IoT-based health monitoring systems have the potential to improve patient outcomes, reduce healthcare costs, and enable remote patient monitoring, making them a valuable addition to the healthcare industry. In addition, these systems can also provide valuable data insights that can be used to identify patterns and trends in patient health, which can help healthcare providers make more informed decisions about treatment plans and interventions. This can ultimately lead to better overall health outcomes for patients.**

*Keywords*— ***Remote Health Monitoring, Diagnosis, Cloud-based IoT Framework, Cost-Effective.***

## I. Introduction

The Internet of Things (IoT)-based Health Monitoring System is a modern solution that leverages the power of technology to provide real-time health monitoring and management. It integrates wearable devices and smart sensors to collect and transmit real-time data to healthcare providers, enabling them to monitor patients remotely and provide timely interventions when necessary. This system offers numerous benefits for patients, healthcare providers, and the healthcare industry as a whole. For patients, it provides an opportunity to take an active role in their own health management by tracking their vital signs and health data in real-time. For healthcare providers, it offers an efficient and convenient solution for health monitoring and management, reducing the need for frequent hospital visits and reducing the pressure on healthcare facilities. Finally, it has the potential to revolutionise the healthcare industry by providing remote monitoring, reducing hospitalisation rates, and improving patient outcomes. Telemedicine can also increase access to healthcare for patients in remote or underserved areas, where there may be a shortage of healthcare providers.

## II. Literature Review

Bouchrika, I., Hamdaoui, M., Guizani, M., suggested that remote health monitoring has become an increasingly important field of research in recent years. With the advent of wearable devices, sensors, and cloud-based technologies, it has become possible to monitor patients' health remotely, enabling early detection and timely intervention for various health conditions. Application for mobile devices [1] Wearable tech, sensors, and cloud computing are all used by the framework to gatherpatient. Agarwal, D., Anand, A., & Verma, P. suggested that [2] the data acquisition component and the cloud-based processing component. The data acquisition component includes various sensors and wearable devices that collect health-related data from the patient, such as body temperature, blood pressure, and heart rate. The cloud-based processing component includes a set of cloud servers that process and store the collected data. Zhiyong Deng 1,2, Lihao Guo 3, Ximeng Chen 1, and Weiwei Wu 3 suggested that [3] that the rapid development of wearable technology has made it possible to collect large amounts of health data in real-time, enabling early detection and prevention of various health problems. They also highlight the importance of accuracy, reliability, and ease of use of these devices. The article discusses various types of sensors used in smart wearable devices, such as electrocardiography (ECG) sensors, photoplethysmography (PPG) sensors, and accelerometers. The authors also explain how machine learning algorithms can be used to analyze the collected data and provide insights into the wearer's health.

Explain that the system consists of an Ashwini Wadhai, Kajal Vaidya, and Sejal Kadak , Piyush Dhurve, Rushikesh Shrikhande, Dr. D.M. Kate et al suggested that [4] The system utilizes a GSM (Global System for Mobile Communications) module to send the patient's health data to a mobile phone and a web application. The data includes information on the patient's heart rate, body temperature, and blood pressure. Wordh Ul Hasan, Mohammad Sultan Khaja, Saif Ahmed & Mohammad Monirujjaman Khan etc suggested that [5] The paper describes a wireless health monitoring system that utilizes a wearable device to continuously monitor and transmit health data to a remote monitoring center. The system includes sensors to measure vital signs such as heart Rate, blood pressure, and temperature, as well as activity levels and sleep patterns. Prajjwal Soam, Prateek Sharma, Neeraj Joshi etc suggested that [6] The paper provides a comprehensive review of health monitoring systems that use IoT (Internet of Things) technology. The authors discuss the benefits of such systems, including the ability to monitor patients remotely and in real-time, reduce the need for in-person visits, and provide more personalized care. The authors provide an overview of the various components of an IoT-based health monitoring system, including sensors, data collection and transmission, and data analysis. They also discuss the challenges associated with developing such a system, such as data security and privacy concerns. Y.Ravi Sekhar, Maradugu Anil Kumar etc suggested that [7] The system utilizes an Android smartphone application to monitor and record various health parameters such as heart rate, blood pressure, and body temperature. The application also includes a medication reminder feature to help patients keep track of their medications. The authors describe the hardware and software components of the system, including the sensors used to measure health parameters and the algorithms used to analyze the data.

They also discuss the user interface of the application and the various features that are available to patients. Prajoona Valsalan, Tariq Ahmed Barham Baomar, Ali Hussain Omar Baabood etl suggested [8] that The system utilizes various sensors to measure health parameters such as heart rate, blood pressure, and body temperature. The data collected by the sensors is transmitted to a central server through an IoT gateway. The authors also developed a web application that allows users to view and analyze the health data in real-time.The authors describe the hardware and software components of the system, including the sensors used to measure health parameters, the IoT gateway, and the web application. Their work has helped to shape and define the problem statement, as well as identify areas for future research and development. The authors would also like to express their gratitude to the scientific community for their ongoing efforts to advance knowledge and technology in this field, and to the various institutions and organizations that have provided support and resources for this research.

## III. METHODOLOGY

The overall system process is shown in Fig 1. Which explains how the heart of the system that is a ESP32 is interfaced with sensors and other components. The proposed iot based Health Monitoring System utilizes several key components to provide comprehensive health monitoring and management. The system consists of wearable devices such as the Max30100 and MPU6050, DHT 11, bmp180, body temperature nodes that collect data from various sensors and transmit it to a central platform. The central platform is responsible for analysing the data using advanced algorithms and detecting any signs of abnormality. In case of an emergency, the system triggers alerts to healthcare providers and provides an interface for healthcare providers to access and view the health data, make diagnoses, and provide treatments. The central platform uses cloud computing technology to store and process the health data and provides real-time monitoring and analysis of the health data, allowing healthcare providers to make diagnoses and provide treatments in a timely manner.

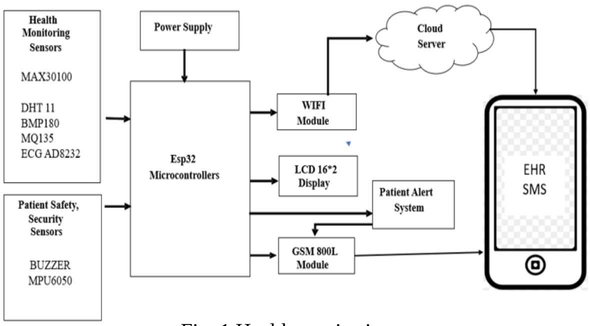


Fig. 1 Health monitoring system

The operation Health Monitoring and Diagnosis with Cloud-based IoT Framework Sensors are attached to each patient to collect vital signs data. The sensors transmit the data to a central IoT platform via wireless communication protocols such as Wi-Fi. The IoT platform collects and analyses the data in real-time, using machine learning algorithms to identify abnormal values or patterns. If abnormal values or patterns are detected, the system can alert healthcare professionals via SMS, email, or push notifications on their smartphones or other devices. Healthcare professionals can access the data and receive alerts on a centralized dashboard or mobile app, allowing them to monitor multiple patients simultaneously. Onelife is a health application that allows users to track and monitor their health status Fig 2 shown Logo of OneLife. It provides features such as tracking of daily physical activities, monitoring of vital signs, and analysis of health data to generate health insights.

Fig. 2 Logo of onelife

In general, vital parameters are clinical measurements that provide important information about a person's health. These may include measurements such as blood pressure, heart rate, respiratory rate, oxygen saturation, and temperature, among others. The app supports single-user mode, which means only one person can use it at a time.

The system we have developed is designed to monitor patients' health conditions in real-time. The system collects data from various sensors including body temperature, ECG, and SPO2 through sensors attached to the patient, which are connected to a module. The module transmits the data via Wi-Fi to an Android app named Onelife. The Android app is developed using the Kodular platform and integrated with Firebase for login authentication and database storage. The Android app requires registration and login for users to access the system. Once logged in, the app instantly starts receiving the data in real-time and visualizes it on the app. The app is also connected to the Firebase server, which stores the data sent by the app over the internet.

*A. Flowchart of the system*

web app has also been developed for this system Fig 3 shown Flowchart of the system. which can be accessed by the caretaker or the doctor to monitor the patient's condition at any given time.

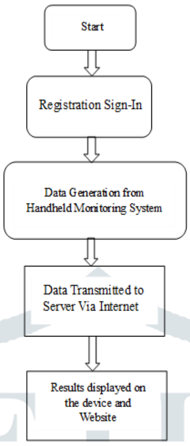
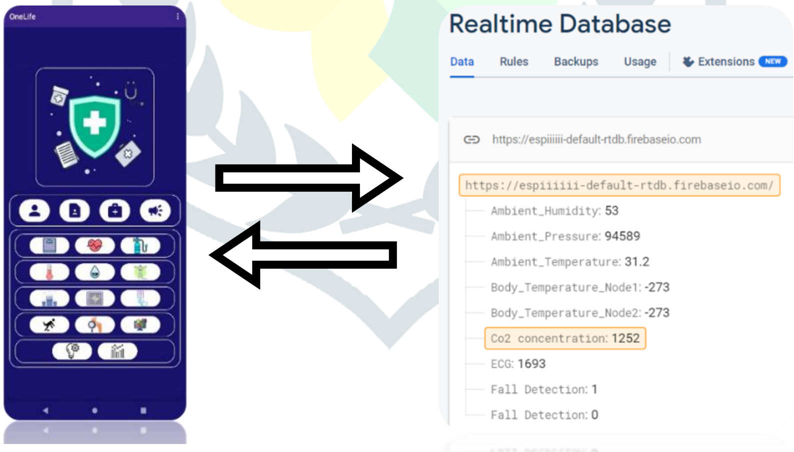



Fig. 3 Flowchart of the system

A web app has also been developed for this system; Flowchart of the system. which can be accessed by the caretaker or the doctor to monitor the patient's condition at any given time. The web app pulls the data from the Firebase database and displays it in real-time. Overall, the system architecture includes the sensors, module, Android app, Firebase server, and web app.The web app pulls the data from the Firebase database and displays it in real-time. Overall, the system architecture includes the sensors, module, Android app, Firebase server, and web app. The Android app is developed using the Kodular platform and integrated with Firebase for login authentication and database storage. The Android app requires registration and login for users to access the system. Once logged in, the app instantly starts receiving the data in real-time and visualizes it on the app. The app is also connected to the Firebase server, which stores the data sent by the app over the internet.




A. Interfacing of application B. Realtime database

Fig.4 A & B shows interfacing bet$^{w}$ application and database

## III. Experimental Results

### *A. Pulse rate*

Pulse oximetry is based on the principle that the amount of RED and IR light absorbed varies depending on the amount of oxygen in your blood. The following graph is the absorption-spectrum of oxygenated hemoglobin (HbO2) and deoxygenated hemoglobin (Hb).As you can see from the graph, deoxygenated blood absorbs more RED light (660nm), while oxygenated blood absorbs more IR light (880nm). By measuring the ratio of IR and RED light received by the photodetector, the oxygen level (SpO2) in the blood is calculated. – (Max30100_led_curr_7_6ma).

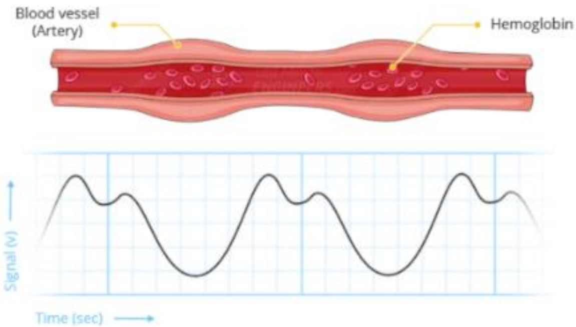
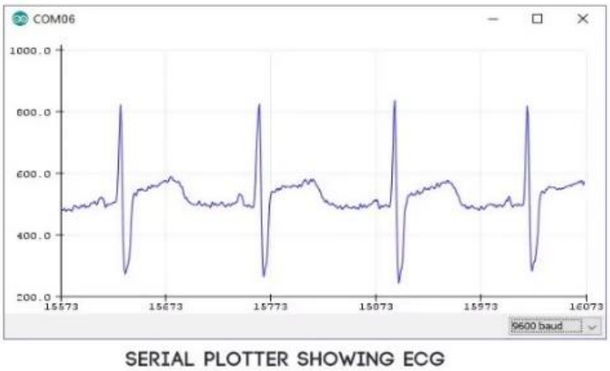




Fig.5 Pulse and oxygen results

### *B. ECG (AD8232)*

Body temperature a graph showing the ECG waveform over time, with a line for each day. The x-axis shows the time of day, and the y-axis shows the voltage of the ECG waveform.



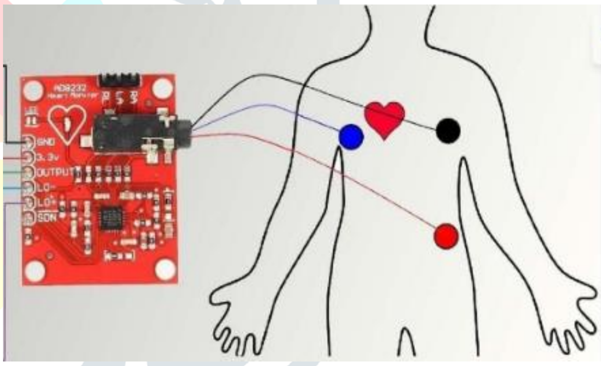
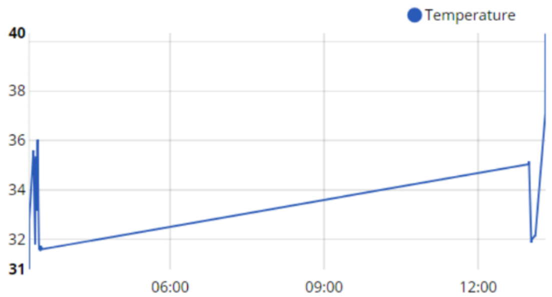




Fig.6 Ecg waveform results

### *C. Body temperature*

A line graph showing the body temperature over time, with a line for each day. The x-axis shows the time of day, and the y-axis shows the body temperature in degrees Fahrenheit or Celsius.



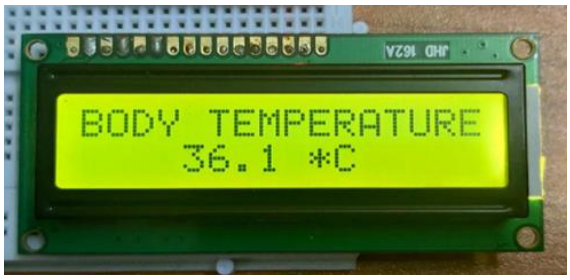




Fig.7 body temperature results

*D. Ambient humidity and temperature.*

A line graph showing the humidity level over time, with a line for each day. The x-axis shows the time of day, and the y-axis shows the humidity level as a percentage.

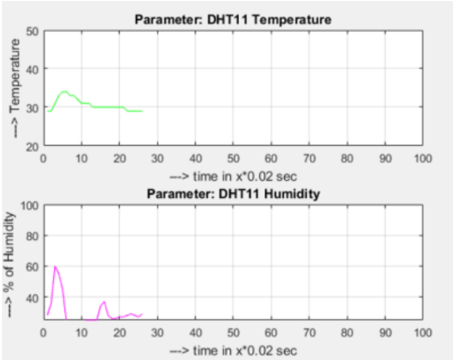




Fig.8 Ambient temperature and humidity results

*E. Website Interface (web page).*

Set up a web server on the ESP32 using the ESPAsyncWebServer library. This allows the ESP32 to serve the web page to a client device, such as a web browser. Use HTML, CSS, and JavaScript to create a web page that displays the sensor readings. You can use HTML to structure the page, CSS to style the page, and JavaScript to retrieve the sensor readings from the ESP32 and update the page dynamically.

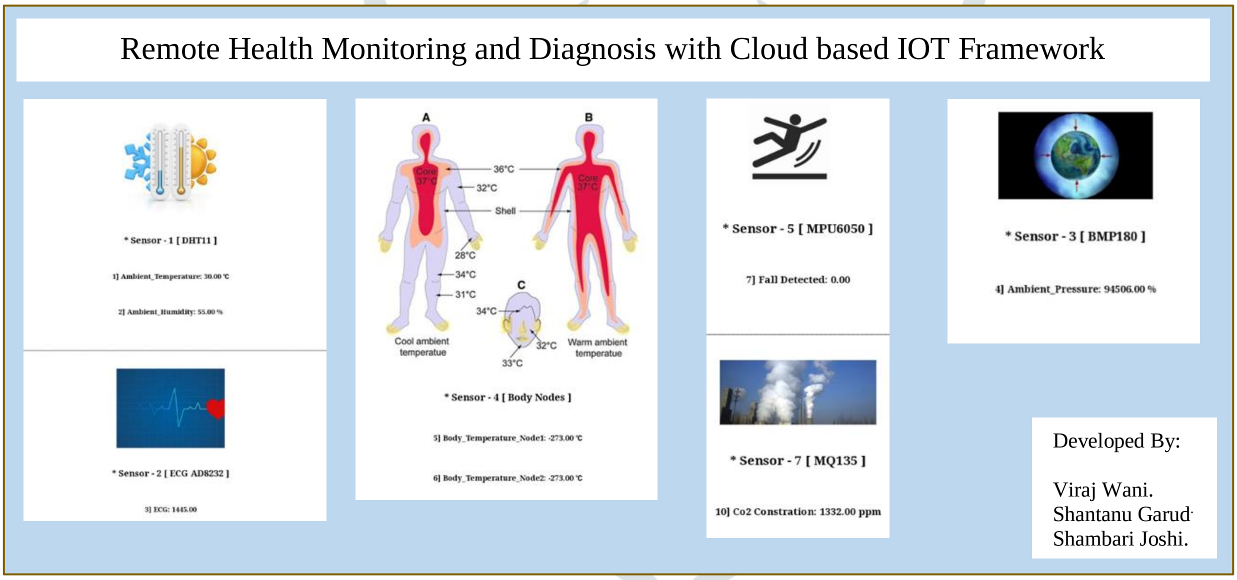



Fig.9 Website interface use html, css

For each sensor, you will need to write code that reads the sensor data and sends it to the web page. You can use the appropriate libraries to read the data from each sensor. For example, you can use the Adafruit_MAX30100 library to read data from the MAX30100 sensor, the Adafruit_MPU6050 library to read data from the MPU6050 sensor, and so on. Once you have the sensor data, you can use JavaScript to update the HTML elements on the web page with the new data. You can use the XMLHttpRequest object or the fetch API to send requests to the ESP32 and retrieve the sensor data. Finally, you can use CSS to style the web page to make it look more visually appealing. You can also use JavaScript to add interactive elements to the web page, such as buttons or sliders, to allow the user to control the sensors or adjust the display settings.

*F. Design an application like OneLife.*

That allows users to login, view a homepage, and track patient health status through graphical representation, you can follow these steps: Define the user flow: Determine the steps that the user will go through when using the app. For example, the user flow may be to login, view a homepage, and then view the graphical representation of patient health status. Design the login page: Create a login page where the user can enter their credentials to access the app. You can use Firebase Authentication to implement the login functionality. Shown on Fig A, B, C.


A. Graphical representation of patient B. Onelife homepage C. Login page

Fig.10 Onelife application

The use of IoT-based health monitoring systems can provide a cost-effective and convenient way of monitoring patients' health in real-time, making it a crucial step in advancing the healthcare industry. The integration of various sensors and communication technologies, as mentioned in the statement, offers a comprehensive approach to health monitoring. The system's ability to remotely monitor patients' health can improve healthcare access, particularly in rural areas or for patients with mobility issues. As technology continues to advance, the potential for widespread adoption of IoT-based health monitoring systems is enormous, and it could revolutionize the healthcare industry, making healthcare more efficient, accessible, and cost-effective.

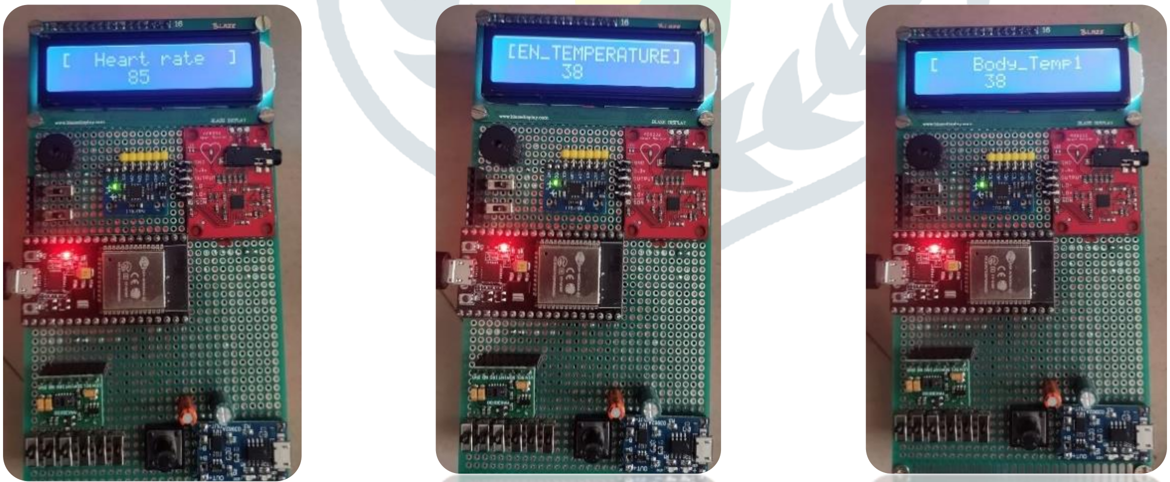



Fig.11 Testing the system

The integration of a glucose sensor, a blood pressure system, in a cloud-based IoT framework for remote health monitoring and diagnosis has the potential to significantly improve the accuracy and effectiveness of the system.

## V. Conclusions and Future Scope

The integration of various sensors like pulse and oxygen, ECG, ambient temperature, pressure, humidity, and body temperature nodes into a cloud-based IoT framework for remote health monitoring and diagnosis has immense potential. Adding fall detection capability to this system can provide an additional layer of safety and support for patients, particularly for those who are elderly or have mobility issues. Moreover, integrating the system with an HTML-based website personal server can provide easy access to patient data for healthcare providers and patients alike, while the use of cloud-based IoT frameworks allows for real-time data analysis and alerts, which can improve the accuracy and reliability of remote monitoring systems. Integrating the system with Google Cloud-based Firebase with a mobile application can further enhance its accessibility and user-friendliness, allowing patients to monitor their health data, receive alerts, and communicate with their healthcare providers in real-time. The mobile application can also provide real-time fall detection alerts to both patients and caregivers, enabling prompt assistance in the event of a fall.

Overall, the integration of various sensors, cloud-based IoT frameworks, and mobile applications with fall detection capability can significantly improve the efficiency and effectiveness of remote health monitoring and diagnosis, leading to better patient outcomes, improved patient experience, and reduced healthcare costs.The integration of a glucose sensor, a blood pressure system, and satellite communication in a cloud-based IoT framework for remote health monitoring and diagnosis has the potential to significantly improve the accuracy and effectiveness of the system. Through continuous monitoring of patients' health, healthcare providers can detect any health issues early, leading to prompt intervention and treatment. However, the collection and storage of personal health data raises ethical concerns related to privacy and security.

## ACKNOWLEDGMENT

We would like to express our gratitude toward various researchers who highlighted future scope and helped in motivating to define problem statement

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