



# IoT-Based Multi-Parameter Health Monitoring System Using ESP32

1Dr. Vinay Kumar H S, 2Keerthana C, 3Rashmi S K, 4Sanjana H N, 5Vaishnavi H V

1Associate Professor , 2UG Student, 3UG Student, 4UG Student, 5UG Student

1P.E.S College of Engineering, Mandya, India ,

2P.E.S College of Engineering, Mandya, India ,

3P.E.S College of Engineering, Mandya, India ,

4P.E.S College of Engineering, Mandya, India ,

5P.E.S College of Engineering, Mandya, India

## Abstract

This project presents a wearable IoT-based health monitoring system capable of measuring physiological parameters including heart rate, SpO<sub>2</sub>, body temperature, skeletal muscle activity, and ECG signals. The system uses ESP32 as the core controller, integrating MAX30102, MLX90614, MyoWare EMG, and AD8232 sensors. Data is transmitted to the Arduino IoT Cloud, where real-time dashboards display the readings and generate alerts when threshold values exceed normal ranges. An SOS push button enables emergency notifications. The system is compact, battery-powered, and suitable for remote monitoring applications.

## Chapter1

### Introduction

Health monitoring has become increasingly important in today's world due to the rise in lifestyle-related diseases and the need for continuous tracking of vital physiological parameters. Conditions such as hypertension, diabetes, cardiac problems, and respiratory issues require regular observation to detect abnormalities early and prevent complications. However, traditional hospital-based monitoring systems are often expensive, stationary, and inconvenient for continuous use. They provide only periodic readings, which may not be sufficient for timely medical intervention.

Wearable biomedical systems have emerged as an effective solution to this challenge. These devices enable non-invasive, real-time monitoring of key health parameters and offer greater mobility and comfort to users. When integrated with Internet of Things (IoT) technology, the collected data can be transmitted to cloud platforms, enabling remote access for patients, caregivers, and healthcare professionals. This approach enhances personal healthcare management by providing continuous visibility into an individual's health status and generating timely alerts in case of irregularities.

This project focuses on developing a portable, battery-powered wearable health monitoring device using an ESP32 microcontroller. Biomedical sensors such as heart rate, temperature, and SpO<sub>2</sub> sensors are interfaced with the ESP32 to collect and process physiological data. The processed information is uploaded to the Arduino IoT Cloud, where it can be visualized through dashboards and monitored in real time. Alert notifications can also be generated when abnormal values are detected. By combining sensor-based monitoring with IoT connectivity, this system aims to support early detection, timely intervention, and improved health management for users.

## Chapter 2

### Literature Survey

- The paper Titled “IoT-Based Pulse and SpO<sub>2</sub> Monitoring Using MAX30102” [1] discusses the increasing global demand for remote health-monitoring systems. Conventional vital-sign measurement methods require physical contact with medical devices or hospital visits. This creates limitations for patients who need continuous observation, such as those with cardiac problems, respiratory illnesses, or post-surgical conditions. To overcome these issues, the authors propose an IoT-based portable monitoring system that uses the MAX30102 biometric sensor to measure heart rate and SpO<sub>2</sub> (blood oxygen saturation) in real time.
- The paper Titled “IoT-Based Wearable Health Monitoring System Using ESP32”[2] proposes an ESP32-based wearable system to monitor vital parameters such as heart rate and body temperature and transmit data to the cloud for real-time monitoring. The work highlights the benefits of IoT-enabled wearables for portable and continuous health tracking.
- The paper Titled “Real-Time Health Monitoring System Using IoT”[3] introduces a real-time health monitoring system that uses Internet of Things (IoT) technology to track essential health parameters. Traditional health monitoring methods require patients to visit hospitals for regular checkups, which is inconvenient and inefficient—especially for elderly patients, chronic disease patients, and emergency situations.

- The paper Titled “Wearable ECG Monitoring Using AD8232” [4] focuses on the development of a wearable ECG (Electrocardiogram) monitoring system using the AD8232 analog front-end (AFE) module. Continuous ECG monitoring is crucial for detecting cardiac abnormalities such as arrhythmia, tachycardia, and atrial fibrillation. Traditional ECG machines are bulky and limited to hospital setups. This paper aims to design a portable, low-power, and wearable ECG system suitable for remote and real-time heart monitoring.
- The paper Titled “Non-contact Temperature Measurement Using MLX90614” [5] Discuss a non-contact temperature monitoring system using the MLX90614 infrared (IR) temperature sensor. Traditional temperature measurement devices such as thermometers or contact probes require physical contact with the skin, which can be uncomfortable, slow, and unhygienic—especially in medical environments. The authors propose a contactless, fast, and accurate temperature measurement system, suitable for medical use (fever screening), industrial monitoring, and automation
- The paper Titled “IoT-Based Pulse Oximetry Using MAX30102”[6] discuss an IoT- enabled pulse oximetry system using the MAX30102 optical biometric sensor. Pulse oximetry is essential for monitoring blood oxygen saturation (SpO<sub>2</sub>) and heart rate, especially in patients with respiratory conditions, cardiac issues, and during emergencies. Traditional pulse oximeters are handheld and lack continuous monitoring or remote data access. The authors propose a low-cost IoT-based solution that measures vital signs in real time and uploads the data to a cloud dashboard accessible to healthcare providers, caregivers, or patients
- This paper Titled “An EMG-Based muscle force monitoring system”[7] discusses the EMG signals from key muscles were analyzed and compared with conventional simulation results. The system showed good correlation with existing methods, indicating reliable performance. However, a small delay was observed, and further improvements are needed for faster real-time applications.
- The paper Titled “Multi-parameter Health Monitoring Wearable”[8] discusses the design and development of a wearable health monitoring device capable of measuring multiple vital health parameters simultaneously. Traditional medical devices typically measure only one parameter (e.g., heart rate, temperature, SpO<sub>2</sub>), and multiple instruments must be used for full diagnosis. To address this limitation, the authors propose a multi-sensor wearable system that continuously monitors several vital signs in real time and sends the data wirelessly to a mobile or cloud platform. This enhances portability, accessibility and early detection of medical condition.

## Chapter 3

### Problem Statement

Continuous monitoring of vital health parameters is essential for early detection of medical issues, but traditional systems are bulky, single-parameter, and confined to hospitals. There is a need for a compact, wearable device that can measure multiple vital signs—ECG, EMG, heart rate, SpO<sub>2</sub>, and body temperature transmit data to an IoT dashboard in real time, and provide automated alerts.

## Chapter 4

### Objectives

The key objectives of our proposed project are as follows:

- To design a biomedical monitoring device that measures heart rate, SpO<sub>2</sub>, temperature, ECG, and EMG signals using low-power sensors.
- To integrate ESP32 with Arduino IoT Cloud for real-time visualization, threshold-based alerts.
- To develop a battery-powered system suitable for continuous, portable health monitoring.

## Chapter 5

### Proposed Methodology

IoT-Based Multi-Parameter Health Monitoring System a structured methodology in which the ESP32 microcontroller coordinates.

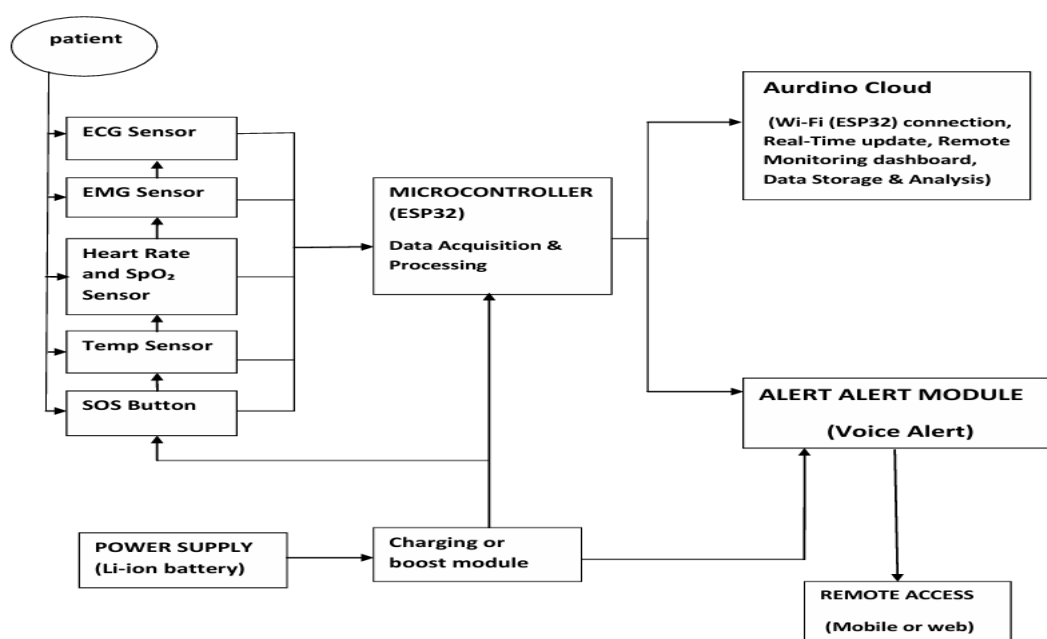


Figure 5.1: Proposed Block Diagram

The above Figure 5.1 shows the IOT-Based Multi-Parameter Health Monitoring system. The system is built around the ESP32 microcontroller, which acts as the central processing and communication unit. Multiple biomedical sensors are interfaced with the ESP32, each responsible for measuring a specific vital parameter: the MAX30102 for SpO<sub>2</sub> and heart rate, the MLX90614 for non-contact body temperature, the Myo ware EMG sensor for muscle activity, and the AD8232 ECG module for cardiac electrical signals. These sensors continuously send analog or digital data to the ESP32 for processing. The ESP32 integrates all incoming data, performs necessary signal conditioning and noise filtering, and prepares the values for local alerts and cloud transmission.

After processing the sensor data, the ESP32 transmits real-time readings to the Arduino IoT Cloud via Wi-Fi. The cloud dashboard displays key health parameters such as SpO<sub>2</sub>, heart rate, body temperature, ECG/EMG signals, and system status alerts. This platform enables remote health monitoring, allowing caregivers or family members to access live data from any location. Threshold-based alerts are automatically generated when abnormal conditions are detected, such as low oxygen saturation, irregular ECG patterns, or elevated body temperature, and emergency SOS notifications can be triggered during critical situations.

In addition to cloud-based alerts, the system provides real-time audible voice alerts for immediate user awareness. The ESP32 employs text-to-speech processing to generate spoken warning messages, which are delivered through a MAX98357 I2S audio amplifier and an external speaker. This feature allows users to hear alerts such as abnormal vital readings without the need to view a display or mobile dashboard, enhancing usability for elderly or visually impaired users.

Power for the system is supplied by a Li-ion battery managed through a charging and boost module, ensuring stable voltage regulation for the ESP32, sensors, and audio components. The module supports safe battery charging while maintaining uninterrupted operation during Wi-Fi communication and voice alert generation. Overall, the system continuously monitors vital parameters, processes data through the ESP32, uploads information to the cloud in real time, and provides both visual and audible alerts, resulting in a portable, IoT-enabled biomedical health monitoring solution.

## Chapter 6

### Hardware and Software Components

#### 6.1 Hardware Components

##### ➤ ESP32 Development Board

As shown in the below figure 6.1, A powerful microcontroller with built-in Wi-Fi and Bluetooth used for processing sensor data, controlling motors, and sending real-time updates to Arduino IoT Cloud. It is the central controller for the entire sorting system.

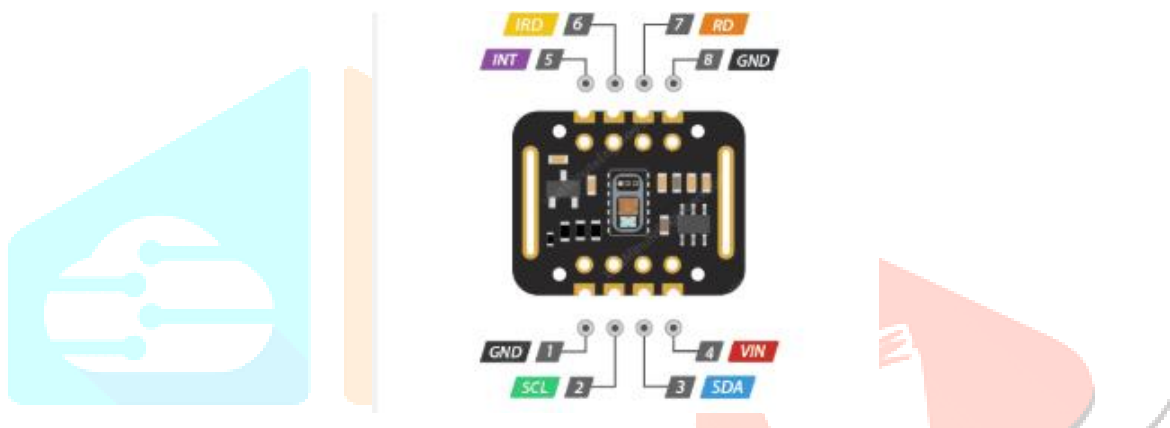


**Figure 6.1: ESP32 Development Board**

➤ **MAX30102 (Heart Rate + SpO<sub>2</sub>)**

As shown in the below figure 6.2, this optical sensor measures blood oxygen saturation and heart rate using infrared and red light.

It provides continuous, non-invasive monitoring of cardiovascular parameters.

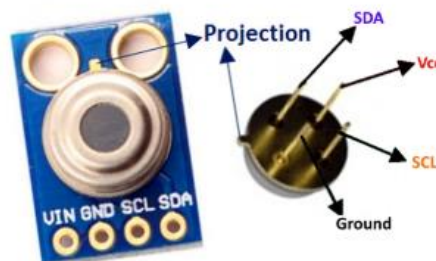


**Figure 6.2: MAX30102 (Heart Rate + SpO<sub>2</sub>)**

➤ **MLX90614 (Body Temperature Sensor)**

As shown in the below figure 6.3, A non-contact infrared thermometer that measures body temperature from a short distance.

It provides accurate temperature readings without physical skin contact.



**Figure 6.3: MLX90614 (Body Temperature Sensor)**

➤ **AD8232 ECG Sensor**

As shown in the below figure 6.4, A low-power ECG front-end module that captures the heart's electrical activity.

It outputs clean ECG waveforms suitable for basic heart monitoring applications.



**Figure 6.4: AD8232 ECG Sensor**

➤ **MyoWare Muscle Sensor (EMG)**

As shown in the below figure 6.5, this sensor detects muscle activation levels by measuring electrical activity from muscle fibers.

It provides amplitude signals that indicate muscle contractions or stress.



➤ **Figure 6.5: L298N Motor Driver**

➤ **SOS Push Button**

As shown in the below figure 6.6, A simple momentary switch that triggers an emergency alert when pressed.

It sends an SOS message to the cloud dashboard for immediate attention.



**Figure 6.6: L298N Motor Driver**

➤ **Li-ion Battery**

As shown in the below figure 6.7, Supplies stable power to the ESP32, sensors, motors, and other hardware components, ensuring portable operation of the system.



**Figure 6.7: Li-ion Battery**

### ➤ Wires and Connectors

As shown in the below figure 6.8, Used for interconnecting all sensors, motors, and modules to the ESP32 and motor driver.

**Figure 6.8: Wires and Connectors**

### MAX98357A

As shown in the below figure 6.9, The MAX98357 is a digital I<sup>2</sup>S audio amplifier that converts digital audio signals from the microcontroller into amplified analog signals. It enables clear and powerful sound output for applications requiring audio playback

**Figure 6.9: MAX98357A**

## 6.2 Software Components

### ➤ Arduino IDE

Used to program the ESP32 and upload the firmware that processes sensor data. Provides a simple interface for coding, debugging, and library management.

### ➤ Arduino IoT Cloud

A cloud platform that displays real-time sensor data using customizable widgets. It also handles alerts, data logging, and SOS message visualization.

### ➤ Board Libraries

These libraries enable communication, Wi-Fi connectivity, and hardware support for ESP32. They allow the microcontroller to run cloud features and manage sensor readings.

### ➤ Sensor Libraries (MAX30102, MLX90614, AD8232, MyoWare)

Each sensor library provides functions for initialization, calibration, and reading values. They simplify integration by converting raw signals into usable biomedical data.

## ➤ Web Dashboard Tools

Used to design and customize IoT widgets like gauges, text boxes, and alerts. They allow intuitive visualization of SpO<sub>2</sub>, heart rate, temperature, and EMG/ECG signals.

### Chapter 7

#### Flow chart with working mechanism

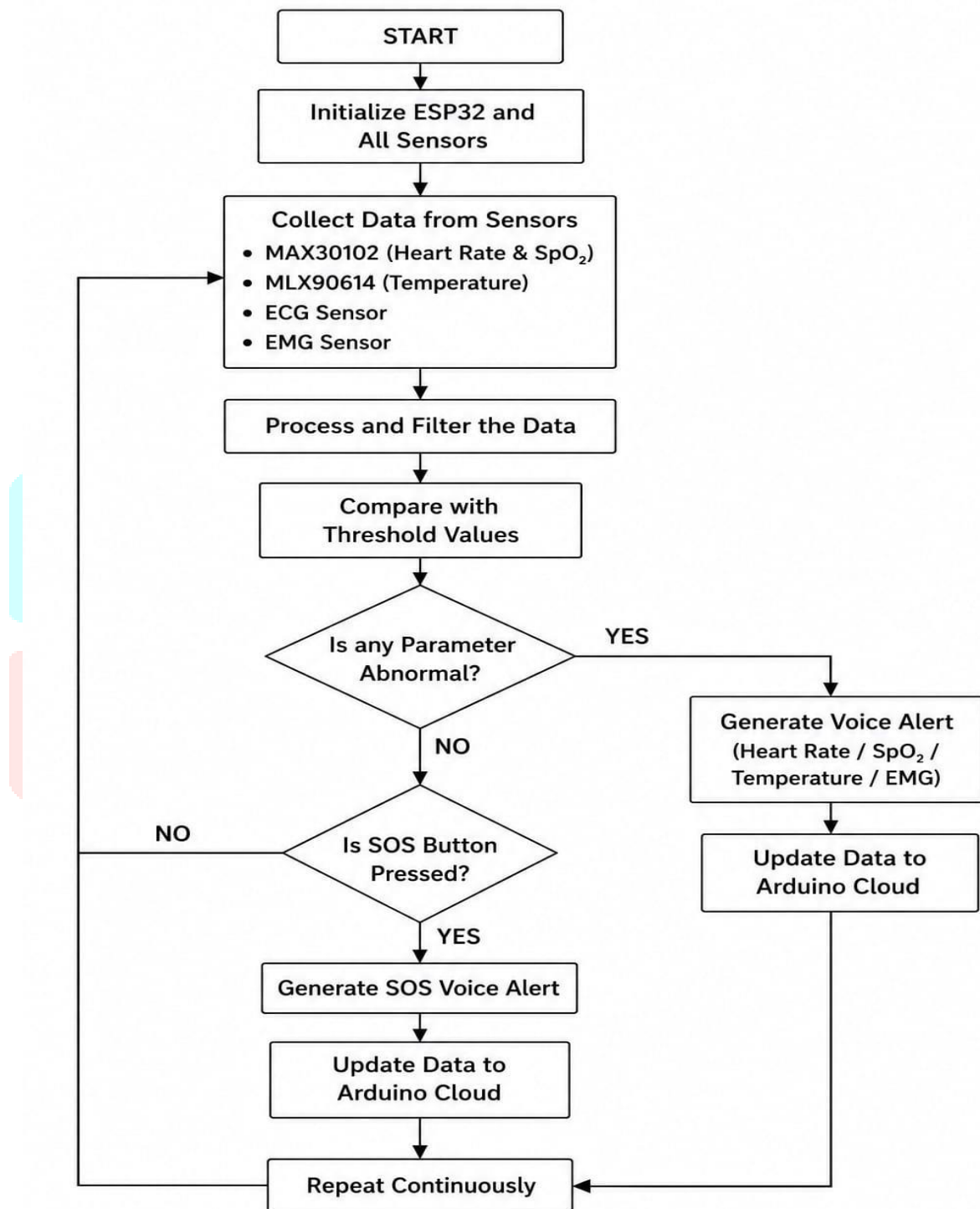


Figure 7.1: Proposed system flow chart

The above proposed system flowchart begins with the **Start** point, representing the initialization of the entire patient health-monitoring system. When the system powers on, the ESP32 microcontroller sets up all connected sensors—ECG (AD8232), EMG (MyoWare), temperature (MLX90614), SpO<sub>2</sub> and

heart rate (MAX30102), and posture sensors—along with the Wi-Fi module. This initialization ensures that all devices are ready for accurate data acquisition and communication with the cloud.

Once the setup is complete, the system moves into the Read Patient Vital Data block. In this stage, the ESP32 continuously collects real-time readings from each sensor. These measurements form the basis for all subsequent operations, such as alerting caregivers or uploading data to the Arduino IoT Cloud. Ensuring timely and precise data collection is critical for detecting any abnormal conditions promptly.

After acquiring sensor values, the flowchart proceeds to Process Sensor Data & Filter Noise. Here, the system applies filtering algorithms to remove unwanted noise from raw sensor signals. This step is crucial for obtaining reliable measurements because sensor readings can often be affected by electrical interference or motion artifacts.

Next, the system moves to Compare with Threshold Values, where each parameter is checked against predefined limits. For example, heart rate, SpO<sub>2</sub>, body temperature, ECG, EMG, and posture are compared against safe ranges. This decision block ensures that any deviations from normal values are immediately identified.

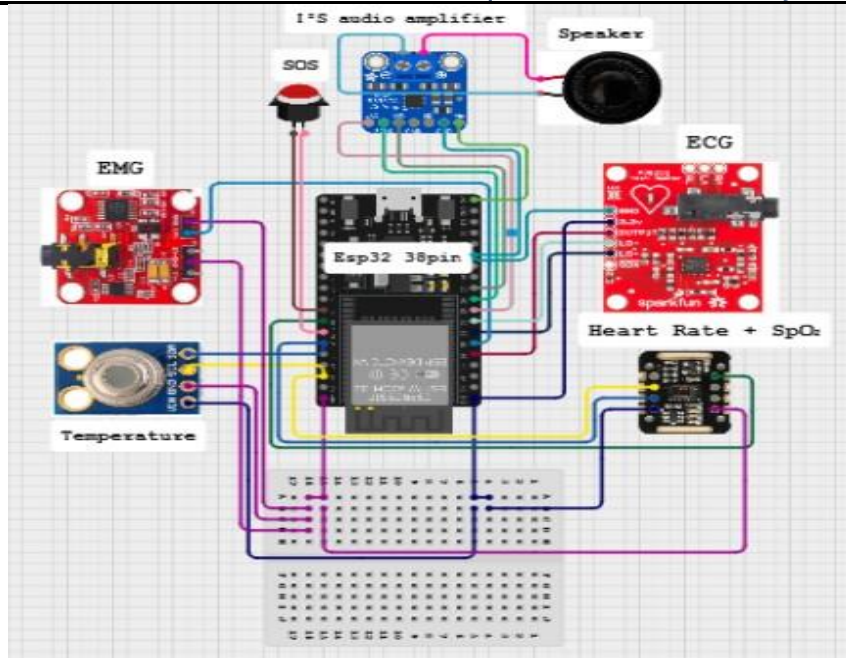
The Abnormal Data? decision block follows. If any measurement exceeds or falls below the threshold, the system interprets this as abnormal data. In such cases, multiple alert mechanisms are triggered. If no abnormal data is detected, the system bypasses the alert steps and proceeds to Upload Normal Data to Arduino Cloud, ensuring that all readings—whether normal or abnormal—are stored remotely. This step provides real-time monitoring, historical data logging, and trend analysis for healthcare providers and caregivers.

After data is uploaded, the system enters Continuous Monitoring, looping back to reading the sensors again. This ensures uninterrupted surveillance of the patient's health parameters, maintaining a real-time feedback loop for early detection and timely response to medical emergencies.

Finally, the process continues indefinitely until the system is manually stopped, represented by the END block.

### **Circuit Diagram of IoT-Based Multi-Parameter Health Monitoring system**

The circuit diagram figure 7.2 illustrates the integration of multiple biomedical sensors with the ESP32 microcontroller to form a complete health monitoring system. The ESP32 acts as the brain of the system, handling data acquisition, processing, and wireless communication. Each sensor is connected based on its functionality and communication protocol.



**Figure 7.2: Proposed System Circuit Diagram**

The ECG sensor (AD8232) is connected through analog pins to capture the electrical activity of the heart. The EMG sensor (MyoWare) detects muscle movements and sends analog signals to the ESP32. The MAX30102 sensor communicates using the I2C protocol and provides SpO<sub>2</sub> and heart rate readings. Similarly, the MLX90614 temperature sensor measures body temperature without contact using infrared sensing.

Additional components such as LEDs, buzzer, and speaker are used for alert mechanisms. A push button is included for emergency (SOS) activation. The breadboard ensures organized connections and stable power supply distribution.

Overall, the circuit is designed for continuous monitoring, accuracy, and real-time data transmission to cloud platforms for remote healthcare applications.

## Chapter 8

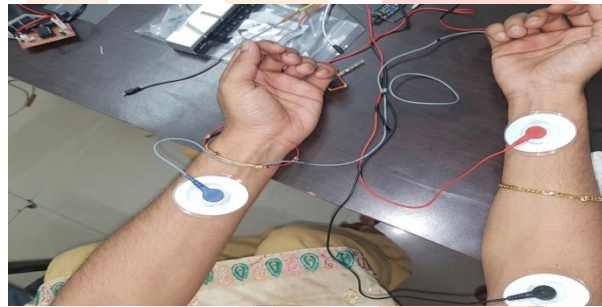
### Results and Discussion

The health monitoring system as shown in the figure 8.1 successfully integrates multiple biomedical sensors with the ESP32 microcontroller to provide real-time monitoring of vital parameters. The system accurately measures temperature, heart rate, SpO<sub>2</sub>, ECG, and EMG signals and displays them on a user-friendly dashboard.



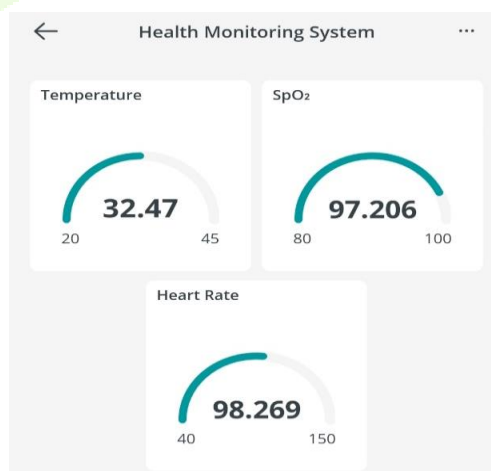
**Figure 8.1: System Model**

It effectively detects abnormal conditions and generates alerts through notifications. The use of IoT technology enables remote monitoring and data storage on the cloud. This project proves to be a reliable, efficient, and cost-effective solution for continuous patient health monitoring.



**Figure 8.2: Experimental setup for ECG signal acquisition.**

### IoT Dashboard Interface and Monitoring



**Figure 8.3: Readings of temperature,spo2,heart rate**

This figure illustrates the graphical user interface (GUI) of a real-time health monitoring system designed to visualize vital physiological parameters. The dashboard utilizes circular gauge charts to

display Body Temperature, Oxygen Saturation (SpO2), and Heart Rate with high-precision decimal output. While the SpO2 (97.206%) and Heart Rate (98.269 BPM) readings fall within a standard healthy resting range, the temperature of 32.47°C suggests a need for sensor calibration to reach the normal 37°C baseline.



Figure 8.4: Normal ECG Reading

The ECG graph provides insight into heart activity by showing peaks and intervals, which can help identify abnormalities. The provided image depicts an ECG (Electrocardiogram) data visualization, likely from a mobile health application or wearable device interface. The X-axis tracks Time over a specific duration, with the current view set to the "1H" (one hour) interval, spanning from approximately 16:45 to 17:45. The Y-axis measures the magnitude of the signal on a scale from 0 to 3k (3,000), representing digital units or raw sensor counts rather than calibrated millivolts. At the top of the interface, several navigation tabs like 15D, 7D, 1D, and LIVE allow the user to switch between long-term trends and real-time monitoring.

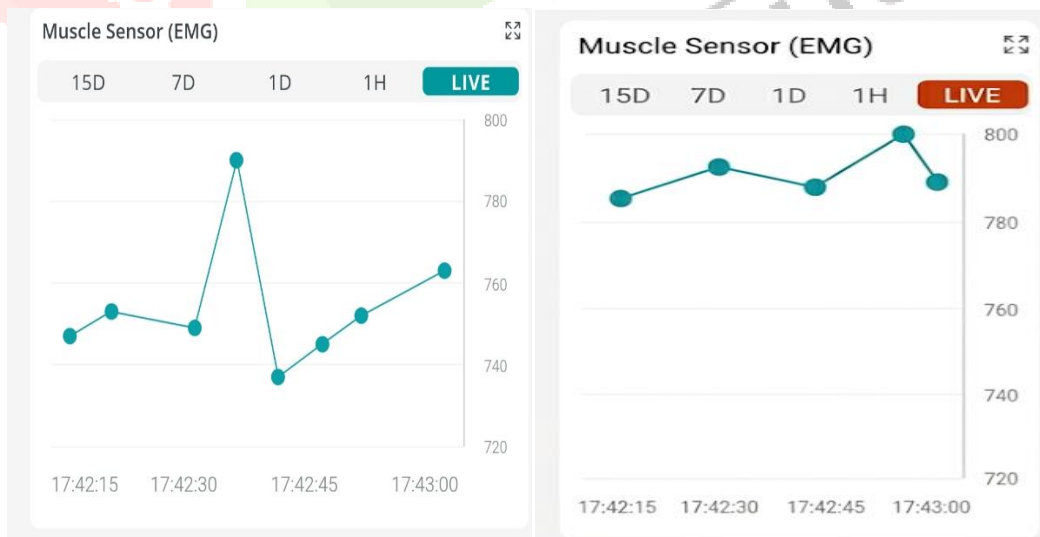


Figure 8.5: (a) Normal EMG Reading

(b) Abnormal EMG Reading

The provided figure illustrates a Muscle Sensor (EMG) dashboard, which monitors the electrical activity of skeletal muscles in real-time. The X-axis represents Time in a detailed format (HH:MM:SS), showing a short observation window of approximately 45 seconds between 17:42:15 and 17:43:00. The

Y-axis measures the Signal Intensity, ranging from 720 to 800; these values represent the magnitude of electrical impulses generated during muscle activation. At the top of the interface, the "LIVE" indicator confirms the data is streaming in real-time, while the time-interval buttons (15D, 7D, 1D, 1H) suggest the user can toggle between this live view and historical trends to track muscle performance over days or hours.

The data points plotted on the graph provide a visual representation of physical effort and muscle "firing." The initial points fluctuate slightly around the 750 mark, indicating a baseline state where the muscle is relatively relaxed. A significant peak occurs just after 17:42:30, where the signal reaches nearly 790, signifying a strong, sudden muscle contraction or "flex." This is followed by a sharp drop to the graph's lowest point (around 738), representing the muscle's transition back to a resting state. Toward the end of the timeline at 17:43:00, the points show a steady upward trend, suggesting that the muscle is beginning to engage in a gradual or sustained contraction once again.

### Observation Table

The observation table1, presents the real-time data collected from various sensors used in the health monitoring system. It includes important parameters such as temperature, heart rate, SpO<sub>2</sub> level, ECG, and EMG signals. The table helps in analyzing the variations in patient health conditions over time.

From the data, it can be observed that the system accurately records sensor values and identifies abnormal conditions when parameters exceed safe limits. The ECG and EMG readings show variations based on heart and muscle activity. The status column indicates whether the condition is normal or requires attention.

This table validates the proper functioning of the system and demonstrates its ability to provide reliable and continuous monitoring of patient health

S.No	Time	Temperature (°C)	Heart Rate (BPM)	SpO <sub>2</sub> (%)	ECG Signal	EMG Signal	Status
1	17:42:15	32.47	98	97	Normal	Moderate	Normal
2	17:42:30	32.50	102	96	Slight Var	High	Alert
3	17:42:45	32.40	95	97	Normal	Low	Normal
4	17:43:00	32.55	105	95	Irregular	High	Alert
5	17:43:15	32.48	99	97	Normal	Moderate	Normal

Table 8.1 : Observation Table

The provided table presents a synchronized log of five key biometric indicators—Temperature, Heart Rate, SpO<sub>2</sub>, ECG, and EMG recorded at 15-second intervals to monitor a subject's physiological state.

The Temperature remains relatively stable, averaging around 32.48°C, which typically indicates a skin-surface measurement rather than internal core temperature. The Heart Rate fluctuates between 95 and 105 BPM, while the SpO<sub>2</sub> (oxygen saturation) maintains a healthy range of 95% to 97%. These vitals are paired with qualitative assessments of the ECG (heart rhythm) and EMG (muscle activity) to provide a comprehensive view of the body's reaction to physical or internal stress over the one-minute observation period.

The most critical aspect of the table is the correlation between high-intensity signals and the resulting Status of the subject. When the EMG signal transitions to "High" (at 17:42:30 and 17:43:00), there is a corresponding spike in Heart Rate and a shift in the ECG signal toward "Slight Variation" or "Irregular" patterns. These specific moments are flagged as an "Alert" status, indicating that the combination of intense muscle exertion and irregular cardiac activity has crossed a safety or monitoring threshold. Conversely, when the EMG signal is "Low" or "Moderate" and the ECG is "Normal," the system registers a "Normal" status, reflecting a state of physiological recovery or rest.

## Applications

The proposed IoT-Based Multi-Parameter Health Monitoring System has several important applications in the healthcare and biomedical field. Some of the major applications are as follows:

### 1. Remote Patient Monitoring

The system allows doctors and caregivers to monitor patient health conditions remotely through the Arduino IoT Cloud dashboard.

### 2. Home Healthcare Systems

Elderly people, chronic patients, and post-surgery patients can continuously monitor their health parameters from home without frequent hospital visits.

### 3. Emergency Health Monitoring

The system generates alerts during abnormal conditions such as irregular heart rate, low SpO<sub>2</sub> levels, high temperature, or abnormal ECG readings.

### 4. Wearable Healthcare Devices

Since the system is portable and battery-powered, it can be used as a wearable biomedical monitoring device for continuous health tracking.

### 5. Fitness and Muscle Activity Monitoring

The EMG sensor helps in monitoring muscle activity, which can be useful in sports training, physiotherapy, and rehabilitation applications.

### 6. Hospital and Clinical Monitoring

The system can assist healthcare professionals in monitoring multiple patient parameters simultaneously in clinics and hospitals.

## 7. **Telemedicine Applications**

Real-time cloud connectivity enables doctors to access patient data remotely and provide medical consultation through telemedicine platforms.

## 8. **Health Monitoring for Disabled and Elderly People**

Voice alerts and SOS emergency features make the system useful for visually impaired, elderly, and physically challenged users.

## **Advantages**

The proposed system offers several advantages over traditional health monitoring methods:

### 1. **Real-Time Monitoring**

Continuously monitors multiple health parameters in real time.

### 2. **Portable and Wearable Design**

The compact and battery-powered system provides mobility and convenience.

### 3. **IoT Connectivity**

Data is uploaded to the Arduino IoT Cloud, enabling remote access from anywhere.

### 4. **Multi-Parameter Measurement**

The system measures ECG, EMG, heart rate, SpO<sub>2</sub>, and body temperature simultaneously.

### 5. **Low Cost and Efficient**

Uses low-cost sensors and ESP32 microcontroller, making the system affordable.

### 6. **Automatic Alert Generation**

Threshold-based alerts notify users during abnormal health conditions.

### 7. **Voice Alert Facility**

Audio alerts improve accessibility for elderly and visually impaired users.

### 8. **Non-Contact Temperature Measurement**

The MLX90614 sensor measures temperature without direct skin contact.

### 9. **Easy Cloud Visualization**

Health data can be easily viewed using IoT dashboards and graphical interfaces.

### 10. **Low Power Consumption**

The ESP32 and biomedical sensors consume less power, improving battery life.

## **Future Scope**

The future enhancements and improvements for the proposed system are as follows:

### 1. **AI-Based Disease Prediction**

Artificial Intelligence and Machine Learning algorithms can be added to predict diseases and detect abnormalities automatically.

## 2. **GPS Tracking Facility**

GPS modules can be integrated to track patient location during emergencies.

## 3. **Advanced ECG and EMG Analysis**

More advanced signal processing techniques can be used for detailed cardiac and muscle analysis.

## 4. **Cloud Database and Medical History Storage**

Patient data can be securely stored in cloud databases for long-term medical analysis.

## 5. **Integration with Smart Hospitals**

The system can be integrated with hospital management systems and electronic medical records.

## 6. **Wireless Charging Support**

Wireless charging technology can improve portability and user convenience.

## 7. **Additional Biomedical Sensors**

Sensors for blood pressure, glucose monitoring, respiration rate, and stress analysis can be added.

## 8. **5G and Advanced Communication Support**

Future systems can use 5G technology for faster and more reliable real-time healthcare monitoring.

## References

- [1] Kavya, Anjali, Ankita, and Ramesh Patil, "IoT-Based Real-Time BPM and SpO<sub>2</sub> Monitoring Using MAX30102," *International Education and Research Journal (IERJ)*, ISSN: 2454-9916, Vol. 10, Issue: 5, pp. 245-250, 2022.
- [2] V. Sindhu, S. Sushmitha, T. Rukmini, and M. C. Varshini, "Medication Of Genes Using DNA Sequence With Machine Learning," *International Journal of Science, Engineering and Technology*, ISSN: 2348-4098, Vol. 11, Issue: 3, pp. 1-6, 2023.
- [3] K. Parvateesam, P. Suresh, K. Madhuri, V. Lokesh, and P. B. Sarojini, "Design and Implementation of Advanced Real-Time Patient Health Monitoring System Using IoT," *International Journal of Engineering Research & Technology (IJERT)*, ISSN: 2278-0181, Vol. 13, Issue: 02, pp. (varies), 2021.
- [4] Bhattarai, C., Yadav, S. K., and Koirala, S., "IoT Based ECG Using AD8232 and ESP32," *Nepal Journal of Science and Technology*, Vol. 21, No. 2, pp. 115-121, 2022, DOI: 10.3126/njst.v21i2.62361.
- [5] Inayatul Inayah, Heri Kiswanto, Achmad Dimiyati, and Muhammad Ghofinda Prasetya, "Design and Implementation of Non-Contact Infrared Thermometer Based on MLX90614 and Ultrasonic Sensors," *Jurnal Fisika dan Aplikasinya*, ISSN: 2460-4682, Vol. 18, Issue: 2, pp. 42-48, 2022
- [6] Kavya, Anjali, Ankita, and Ramesh Patil, "IoT-Based Pulse Oximetry Using MAX30102 with Cloud Monitoring," *International Education and Research Journal (IERJ)*, ISSN: 2454-9916, Vol. 10, Issue: 5, pp. 245-250, 2022.

[7] Jongsang Son, Sungjae Hwang, and Youngho Kim, “An EMG-Based Muscle Force Monitoring System,” *Journal of Mechanical Science and Technology*, ISSN: 1738-494X, Vol. 24, Issue: 10, pp. 2099-2105, 2020.

[8] Ascioğlu, G. and Senol, Y., “Design of a Wearable Wireless Multi-Sensor Monitoring System and Application for Activity Recognition Using Deep Learning,” *IEEE Access*, Vol. 8, pp. 169183-169195, 2023.

