

# Heart Defect Monitoring System Using Ecg Using Iot

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**Abstract**—This paper introduces an intelligent vital signs monitoring system that combines wearable IoT devices with machine learning to enable continuous, real-time health tracking. Sensors collect key data like heart rate, blood oxygen and send it to an ESP32 microcontroller, which processes and uploads the information to the cloud. Machine learning algorithms then analyze the data to classify normal vs abnormal conditions and predict potential health risks. An alert mechanism notifies patients or caregivers immediately if something unusual is detected. This affordable, scalable design is intended to improve healthcare access, support early diagnosis, and enhance patient safety[4]. Such IoT-based remote monitoring has been shown to improve quality of life by enabling secure, real-time patient observation[3].

## I. Introduction

In recent years, healthcare has undergone a significant transformation thanks to advanced technologies, allowing doctors to intervene earlier and manage chronic illnesses more effectively[5]. Wearable IoT devices are now a powerful solution for real-time monitoring: by continuously collecting vital signs, they provide detailed data streams about a person's health. However, most current devices only display raw data and do not analyze it, so they miss opportunities for proactive intervention. To address this gap, we integrate machine learning with IoT monitoring, enabling the system to learn from data and predict problems before they happen shifting from reactive care to proactive care. For example, a recent study shows that combining IoT sensors with ML models can detect anomalies in vital signs with over 90% accuracy[4].

This project proposes an intelligent vital signs monitoring system using wearable sensors and machine learning. The system continuously tracks patient health and is especially beneficial for elderly patients, people with chronic conditions, and telemedicine applications. By processing data on a microcontroller and sending it to the cloud, the system delivers real-time insights while remaining cost-effective and scalable. In summary, our design aims to extend healthcare beyond hospitals by providing constant, intelligent monitoring and timely alerts to improve patient outcomes.

Embedded systems form the backbone of our monitoring device. An embedded system combines software and hardware to perform specific tasks under real-time constraints. In our

system, an ESP32 microcontroller acts as the embedded "brain", gathering sensor inputs and running data analysis. We also discuss some hardware basics eg. Power supply, sensors to support this understanding. Importantly, IoT technology connects our device to cloud services. IoT healthcare applications have been shown to improve care by enabling secure remote patient monitoring[3]. By adopting IoT, our system can alert doctors or family members instantly through the internet whenever a patient's vital signs indicate a potential problem.

## II. LITERATURE SURVEY

The growing impact of IoT and machine learning in health monitoring. For example, a survey of IoT healthcare systems highlights their role in improving life quality through real-time monitoring[3]. Other works demonstrate that applying ML to vital sign data enables early anomaly detection. Deshmukh et al. 2025 developed a similar IoT+ML system with photoplethysmography sensors that predicts heart rate and SpO2 anomalies with >90% accuracy[4]. These studies illustrate that integrating sensors with cloud analytics creates a robust framework for early detection of health issues and ultimately better patient care. Our design builds on this foundation by employing affordable components and ML algorithms to provide comparable benefits.

Research on wearable healthcare devices highlights their importance in improving patient comfort and mobility. Wearable sensors allow individuals to monitor their health without frequent hospital visits, making them especially useful for elderly people and patients with chronic diseases. Modern wearable systems can track multiple parameters simultaneously and transmit data wirelessly. Despite these advantages, challenges such as limited battery life, sensor accuracy, reliability, and energy efficiency still affect their large-scale adoption.

The introduction of Machine Learning into healthcare monitoring has brought significant improvements in data analysis and decision-making. Various ML algorithms, including Decision Trees, Support Vector Machines(SVM),

and Random Forest, have been widely used to classify health conditions and predict potential risks. These algorithms can analyze large volumes of medical data and identify hidden patterns that are not easily detectable by humans. However, many existing ML-based systems are developed using offline datasets and are not fully integrated with real-time IoT environments, limiting their practical applicability.

### III. EXISTING SYSTEM

The existing healthcare monitoring systems are predominantly based on conventional hospital-centric approaches, where patients are required to visit medical facilities for routine check-ups and diagnosis. These systems rely on periodic monitoring rather than continuous observation, which significantly limits their ability to detect early warning signs of critical health conditions [1]. As a result, many serious diseases remain unnoticed during the intervals between medical examinations, leading to delayed diagnosis and treatment.

In traditional systems, vital parameters such as heart rate, body temperature, and oxygen saturation are measured using bulky and expensive medical equipment. These devices are generally confined to clinical environments and are not suitable for portable or real-time monitoring. Moreover, the collected data is typically presented in raw form without any intelligent interpretation, thereby increasing dependency on healthcare professionals for analysis and decision-making [2].

Although some modern systems incorporate IoT-based technologies, they often lack advanced analytical capabilities. Most of these systems operate on simple threshold-based mechanisms, where alerts are triggered only when predefined limits are exceeded. This approach is insufficient for identifying complex patterns or predicting potential health risks, thus reducing overall system effectiveness [1].

Furthermore, existing systems often do not support real-time data transmission and remote accessibility, which are crucial for emergency situations and remote patient care. The absence of continuous monitoring, intelligent analysis, and predictive functionality makes these systems less efficient in ensuring proactive healthcare management [2].

### IV. PROPOSED METHODOLOGY

The Intelligent Vital Signs Monitoring System that combines wearable technology, Internet of Things and Machine Learning (ML) to provide continuous, real-time, and remote healthcare monitoring. Unlike traditional healthcare systems that depend on periodic hospital visits, this system enables uninterrupted monitoring of a patient's health

condition, ensuring early detection of potential risks and timely medical intervention.

At the core of the system are wearable sensors that continuously measure important physiological parameters such as heart rate, body temperature, electrocardiogram (ECG), and oxygen saturation (SpO<sub>2</sub>). These sensors are designed to be compact, comfortable, and user-friendly, allowing patients to wear them for long durations without discomfort. The continuous data collection ensures that even minor variations in health conditions are captured and analyzed effectively.

The collected data is processed using a microcontroller unit, such as ESP32 or Raspberry Pi, which acts as the central processing component of the system. This controller gathers sensor data, performs initial preprocessing, and transmits the information to cloud platforms using IoT communication technologies such as Wi-Fi. This connectivity enables real-time data transfer and ensures that patient information is available remotely for monitoring and analysis.

A key feature of the proposed system is the integration of Machine Learning algorithms for intelligent data analysis. The system performs several steps, including data preprocessing, feature extraction, and classification of health conditions into normal and abnormal categories. In addition, the ML model analyzes patterns in historical and real-time data to predict potential health risks before they become critical. This predictive capability transforms the system from a reactive monitoring tool into a proactive healthcare solution.

To enhance patient safety, the system incorporates a real-time alert mechanism. Whenever abnormal readings or critical conditions are detected, automatic alerts are sent to patients, caregivers, or medical professionals through mobile applications or cloud-based notifications. This ensures immediate response during emergencies and reduces the risk of severe health complications.

### V. BLOCK DIAGRAM & WORKING SYSTEM

#### BLOCK DIAGRAM

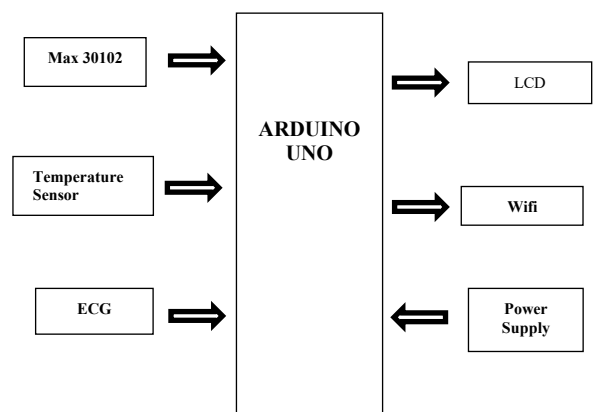


Fig: 4.2:Block Diagram

## VI. WORKING SYSTEM

The working system of the proposed Intelligent Vital Signs Monitoring System is designed to provide continuous, real-time, and automated healthcare monitoring using wearable IoT devices integrated with Machine Learning techniques. The system operates through a sequence of data acquisition, processing, transmission, analysis, and alert generation to ensure efficient and proactive healthcare management [1].

Initially, wearable sensors such as heart rate sensors, temperature sensors, ECG modules, and SpO<sub>2</sub> sensors are used to continuously collect physiological data from the patient's body. These sensors are connected to a microcontroller unit, such as Arduino or ESP32, which acts as the central processing unit of the system. The microcontroller reads the sensor data at regular intervals and performs basic preprocessing to remove noise and ensure data accuracy [2].

Once the data is processed, it is transmitted to a cloud platform using IoT communication technologies such as Wi-Fi modules. This enables real-time data storage and remote accessibility, allowing healthcare professionals to monitor patient conditions from any location. The cloud platform serves as a centralized database for storing historical and real-time health data, which is essential for further analysis and decision-making [1].

Machine Learning algorithms are then applied to the collected data to perform intelligent analysis. The system uses techniques such as classification and pattern recognition to distinguish between normal and abnormal health conditions. Additionally, predictive models are used to identify potential health risks based on trends in the patient's vital signs. This enhances the system's capability to provide early warnings and supports preventive healthcare [2].

An alert mechanism is integrated into the system to ensure immediate response during critical situations. Whenever abnormal readings or potential health risks are detected, notifications are automatically sent to patients, caregivers, or doctors through mobile applications or messaging services. This real-time alert system improves emergency response time and ensures patient safety [1].

Furthermore, the system includes a display unit such as an LCD to provide instant feedback to the user. The entire system is designed to be portable, cost-effective, and scalable, making it suitable for applications such as remote patient monitoring, elderly care, and chronic disease management [2].

## VII. RESULTS AND OUTCOMES

The implementation of the proposed Intelligent Vital Signs Monitoring System demonstrates effective performance in continuous health monitoring and real-time data analysis. The system successfully integrates wearablesensors, IoT technology, and Machine Learning tedchniques to provide accurate and reliable monitoring of vital physiological parameters such as heart rate, body temperature, ECG, and oxygen saturaion (SpO<sub>2</sub>).

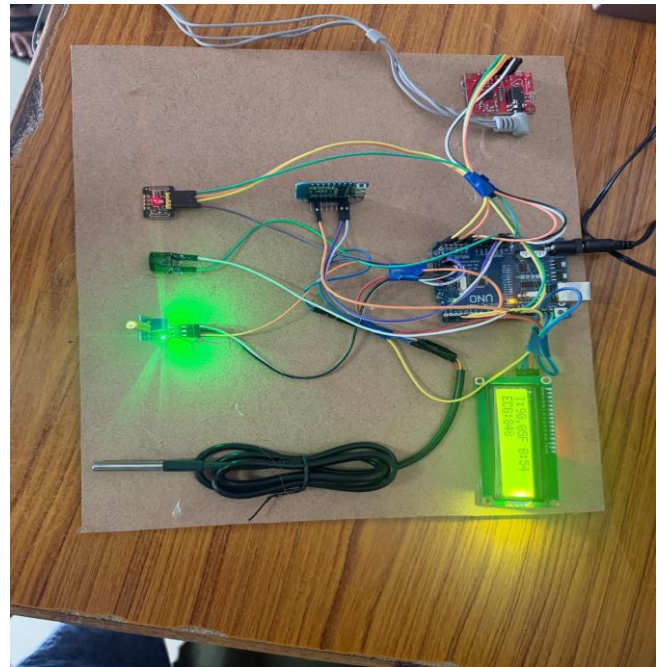


Fig:7.1: Output 1

During the testing phase, the wearble sensors were able to continously collect physiological data without significant interruptions. The microcontroller unit efficiently processed the sensor inputs and transmitted the data to the cloud platform in real time. The communication between the hardware components and cloud platform in realtime. The communication between the hardware components and cloud system was stable, ensuring seamless data flow and remote accessibility.

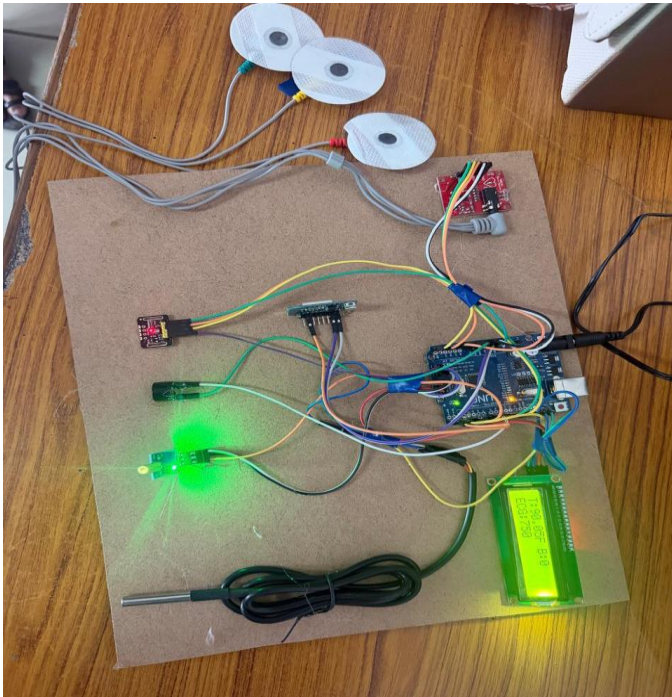


Fig:7.2: Output2

The Machine Learning component of the system played a crucial role in analysing the collected data. It successfully classified health conditions into normal and abnormal categories based on predefined patterns and trained models. In addition, the system demonstrated the ability to identify irregularities in vital signs at an early stage, which is essential for preventive healthcare. This confirms that the integration of ML enhances the intelligence of the monitoring system compared to traditional methods.

One of the significant outcomes of the system is the successful implementation of the real-time alert mechanism. Whenever abnormal readings were detected, alerts were generated and sent immediately to the user or caregiver. This feature ensures quick response during emergency situations and reduces the chances of severe health complications.

The cloud-based platform effectively stored large volumes of health data and provided easy access for monitoring and analysis. Users were able to visualize real-time and historical data, enabling better understanding of health trends. This improves decision-making for both patients and healthcare professionals.

The system also proved to be cost-effective and portable, making it suitable for real-world applications. It reduces dependency on hospital-based monitoring and allows patients to be monitored from their homes. This is particularly beneficial for elderly individuals and patients with chronic diseases who require continuous supervision.

## VIII. CONCLUSION

The proposed Intelligent Vital Signs Monitoring System using Wearable IoT Devices and Machine Learning presents an effective and modern solution for continuous healthcare monitoring. By integrating wearable sensors with IoT technology, the system enables real-time tracking of essential physiological parameters such as heart rate, body temperature, ECG, and oxygen saturation ( $SpO_2$ ), ensuring continuous observation of a patient's health condition.

The incorporation of Machine Learning techniques significantly enhances the system's capability by enabling intelligent data analysis, classification of health conditions, and prediction of potential health risks. This shifts the healthcare approach from reactive treatment to proactive monitoring, allowing early detection of abnormalities and timely medical intervention.

Furthermore, the implementation of a real-time alert mechanism ensures that critical health conditions are immediately communicated to patients, caregivers, or healthcare professionals. This feature plays a vital role in improving patient safety and reducing the chances of severe complications. The use of cloud-based platforms also allows efficient data storage, remote accessibility, and easy monitoring from any location.

The system proves to be cost-effective, portable, and scalable, making it suitable for a wide range of applications such as remote patient monitoring, elderly care, chronic disease management, and telemedicine. It reduces the dependency on hospital-based monitoring and minimizes the need for frequent medical visits, thereby saving time and healthcare costs.

The developed system demonstrates the potential of combining IoT and Machine Learning in transforming traditional healthcare systems into smart, efficient, and patient-centric solutions. Future enhancements may include the integration of advanced predictive models, improved data security mechanisms, and real-world clinical validation to further increase system reliability and effectiveness.

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