Predictive Health Monitoring for Proactive Public Safety and Management

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***Abstract*— This study introduces a cost-effective wearable system designed to monitor vital health indicators in real time using technology related to the internet of things and machine learning (ML) (IoT). The suggested remedy comprises of an intelligent wristband equipped with biomedical sensors—such as MAX30100 for monitoring heart rate and SpO_2, DS18B20 for temperature tracking, MQ-135 for detecting CO_2, and an accelerometer for identifying falls. The sensors are attached to a NodeMCU ESP8266 microcontroller, which transmits data wirelessly to a cloud-based dashboard. A Logistic Regression model is employed to classify critical health events based on the sensor data. When an abnormal condition is detected, the system immediately sends a WhatsApp alert along with the user's location. This approach offers an accessible, continuous health monitoring solution that enhances emergency responsiveness, particularly for vulnerable people like the elderly or those in remote areas.**

I. INTRODUCTION

Wearable health technologies are transforming healthcare by enabling continuous, on-the-go monitoring of vital signs. Conventional methods for health tracking often rely on bulky equipment, require clinical settings, and may not provide real-time feedback—posing limitations for day-to-day health management, especially for elderly or at-risk individuals in remote regions.

In order this project aims to close these gaps. suggests a smart, affordable wristband that leverages the capabilities of the The Internet of Things (IoT) and machine learning (ML).The system monitors essential health parameters such as heart rate, oxygen saturation (SpO_2), body temperature, environmental CO_2 levels, and physical movement using compact biomedicalsensors.

The gathered data is processed by the NodeMCU ESP8266 microcontroller and transmitted wirelessly to a cloud-based platform for real-time visualization. To further enhance its intelligence, the system integrates a Logistic Regression algorithm that predicts critical health events based on sensor readings. If any abnormality is detected, the system sends instant WhatsApp alerts containing the user's live GPS location, allowing timely medical intervention. This combination of IoT and ML technologies offers a proactive and scalable approach to health monitoring for both personal and public safety applications.

II. LITERATURE SURVEY

Numerous investigations have examined the application of IoT in health monitoring systems, especially for wearable technology. Most commercially available devices, such as smart watches, are optimized for general fitness tracking and lack the capability to deliver real-time emergency responses or detailed clinical insights.

In one study, Gupta et al. (2020) presented a health monitoring prototype using an Arduino platform and GSM module to transmit sensor data. While this approach allowed basic alerting via SMS, it lacked advanced data analytics and real-time cloud visualization.

Similarly, Rani et al. (2021) developed a wearable device using temperature and heart rate sensors with Bluetooth connectivity. However, its limited transmission range posed challenges for remote or continuous monitoring.

Patil et al. (2022) focused on ML utilizing logistic regression for health prediction but their system functioned primarily offline, limiting its use in real-time emergency response scenarios.

Kumar and Sharma (2023) proposed a wearable IoT system to measure heart rate and SpO_2. While promising, their design did not incorporate ML or automated alert mechanisms.

In contrast, Our suggested system combines several health sensors with a real-time machine learning and cloud-based IoT platformsdriven anomaly detection. The system's ability to send instant WhatsApp alerts with location details sets it apart as a robust solution for real-time healthcare monitoring and emergency management.

SCOPE OF STUDY

The scope of this project encompasses the development, implementation, and evaluation of an IoT-based wearable device integrated with machine learning to monitor vital health parameters and provide real-time feedback. This system is designed to address key challenges in healthcare by offering a comprehensive solution for continuous health monitoring, emergency response, and preventive care. Below is a detailed exploration of the project's scope:

- The wearable device will continuously measure critical vital health metrics, such as heart rate , SpO2 levels, body temperature, as well as CO2 levels using advanced sensors.
- High-precision sensors, including the MAX30100 for heart rate and SpO2 measurement, the B818B20 temperature sensor as well as a CO2 gas sensor,will be incorporated into the system to guarantee dependability data collection.
- Arduino platform, the development

  ofArduinocodeforefficientdataacquisitionandprocessing, The data collected will be analyzed in real-time, providing immediate insights into the user's health status.
- Logistic regression, An algorithm for machine learning will be used to categorize the user's health status as either "Normal" or "Abnormal."

- Sensor data will be examined by the system to find trends and spot irregularities to help discover possible health problems early.

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III. BLOCKDIAGRAM

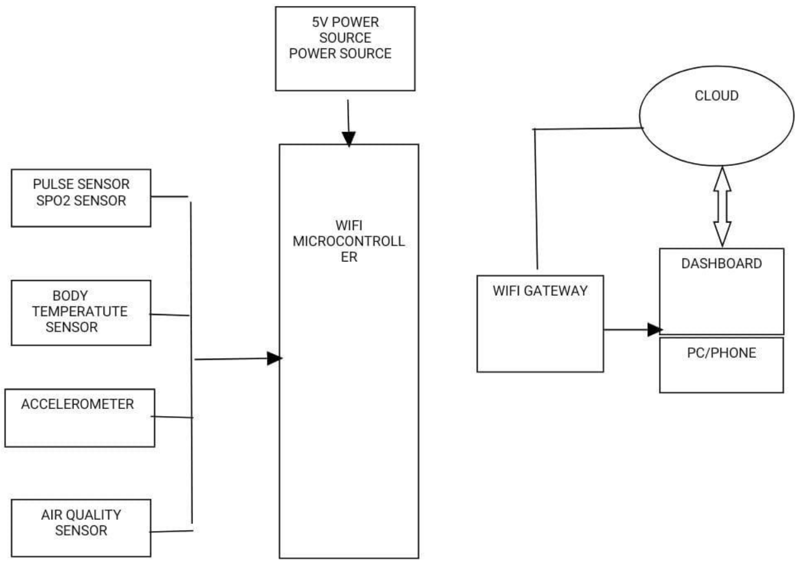

Fig.1BlockDiagram

1. The proposed system is a compact, wearable solution engineered to continuously track multiple health parameters through an integrated sensor network.

2. These sensors are embedded within a wristband and interface with a NodeMCU ESP8266 microcontroller, which acts as the core processing unit.

3. The system records essential physiological parameters such as heart rate, oxygen saturation (SpO_2), body temperature, carbon dioxide levels, and movement activity.

4. Once collected, the sensor data is processed and transmitted wirelessly to a cloud server using Wi-Fi, enabling remote access to health metrics via a real-time dashboard.

5. The architecture also incorporates a Machine Learning algorithm—specifically, Logistic Regression—which analyzes the sensor readings to identify potential health risks.

6. A critical feature of this system is its emergency alert capability. When abnormal readings are detected, a WhatsApp message containing both the alert and the user's live GPS location is automatically sent to a preconfigured emergency contact, allowing for timely response and intervention.

Hardware Components:

- MAX30100: Dual-function sensor used to measure both heart rate and SpO_2.
- DS18B20: A digital temperature sensor known for its accuracy and one-wire communication.
- MQ-135: Gas sensor for detecting CO_2 levels and monitoring air quality.
- **Accelerometer (MPU6050 or ADXL345):** Detects physical movement and sudden impacts to identify potential falls.
- ESP8266 NodeMCU: Microcontroller that reads data from each sensor and manages wireless communication via built-in Wi-Fi.

Software Tools and Platforms:

- Arduino IDE: For programming and uploading firmware to the NodeMCU.
- Python: Used to implement the Logistic Regression model.
- ThingSpeak/Blynk: Cloud services used to visualize and track real-time sensor data.

- Twilio API: Enables automated WhatsApp messaging for emergency alerts.

In an Internet of Things-based wearable health monitoring system, functional requirements refer to the specific capabilities and operations that the system must support to achieve its intended functionality. The goal of such a system is to monitor various health parameters in real-time, such as heart rate, SpO2 levels, CO2 concentration, body temperature, and movement speed. Additionally, it should provide alerts for abnormal conditions, track the user's location, and provide a mechanism for emergency response. The following sections describe the primary functional requirements for the IoT-based wearable health monitoring system, ensuring that it delivers the necessary features for effective health management and safety monitoring.

IV. SCHEMATICDESIGN

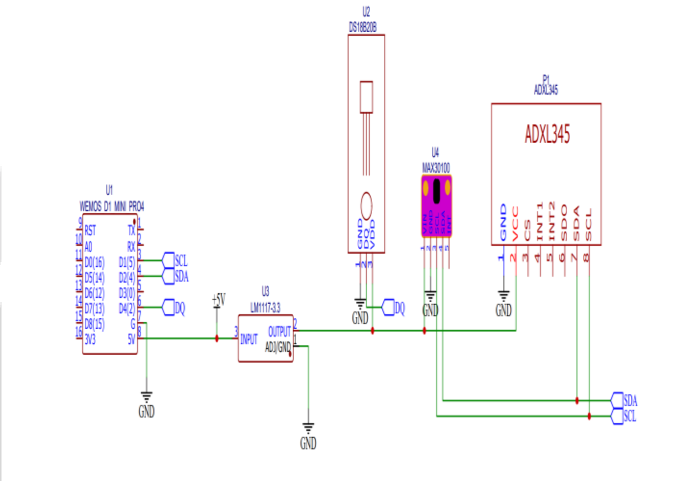

Fig.2 Schematic Diagram

V. FLOWCHART

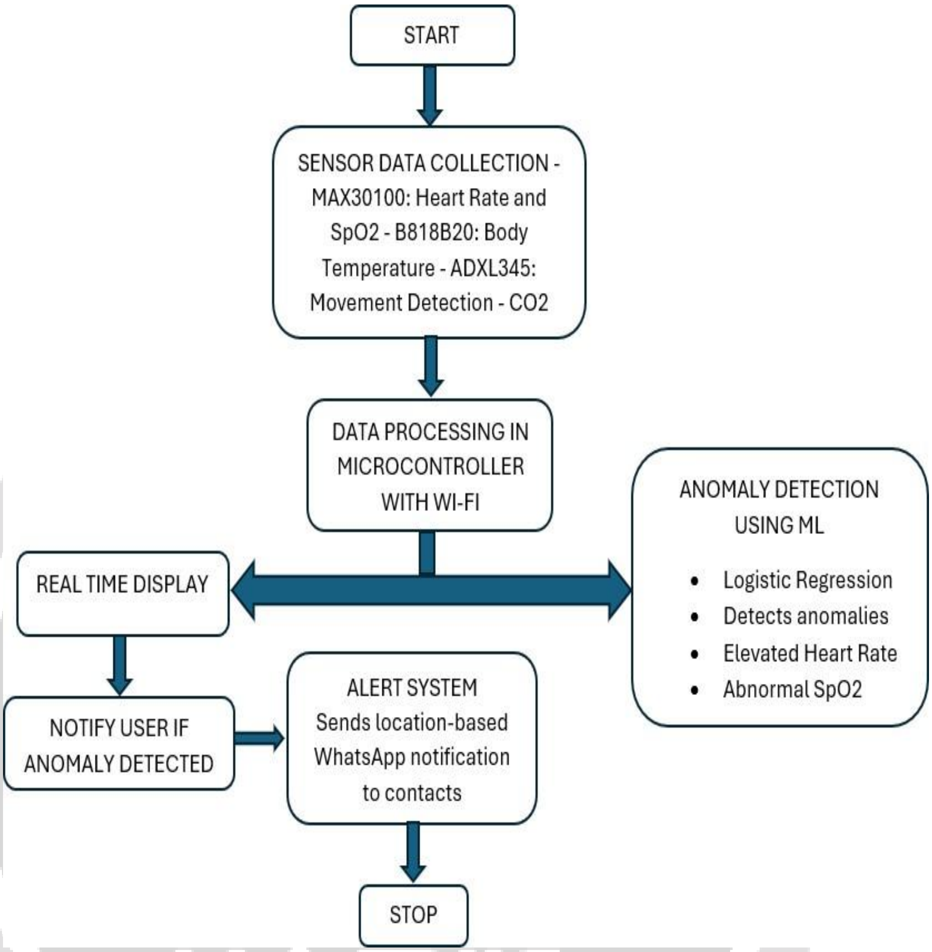

Fig.3Flowchart

VI. FINAL RESULTS

This project successfully demonstrates the feasibility of developing an IoT-based wearable device for real-time health monitoring and early anomaly detection. The integration of a diverse array of sensors, including the MAX30100 for heart rate and SpO2, the B818B20 for temperature, the ADXL345 for movement detection, and a gas sensorforCO2levels,provides a comprehensive assessment of the wearer's physiological state. The system's ability to continuously monitor these vital parameters and generate real-time alerts for abnormal readings enhances its potential for timely intervention and improved health outcomes. The implementation of a A logistic regression model for
for anomalies detection, while a preliminary step, demonstrates the potential of machine learning in identifying potential health risks. By analyzing patterns in sensor data, the
modelcanflagunusualreadingsorcombinationsofreadingsthatmayindicateunderlying health issues. Additionally, integrating Wi-Fi transmission to a central server or enabling data processing, remote monitoring, and the possibility of exchanging data with healthcare providers
For personalized guidance and support. While this project demonstrates a proof-of-concept, several limitations need to be addressed for practical real-world applications. The accuracy of the system heavily relies on the system's accuracy is largely reliant on the precision and dependability of
the integrated sensors. Factors such as sensor placement, environmental conditions (temperature, humidity), and individual physiological variations can significantly influence sensor readings.

VII. REFERENCES

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