iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** VII **Month of publication:** July 2025

DOI: https://doi.org/10.22214/ijraset.2025.73110

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

IoT-Based Remote Patient Health Monitoring System Using Raspberry Pi and Machine Learning

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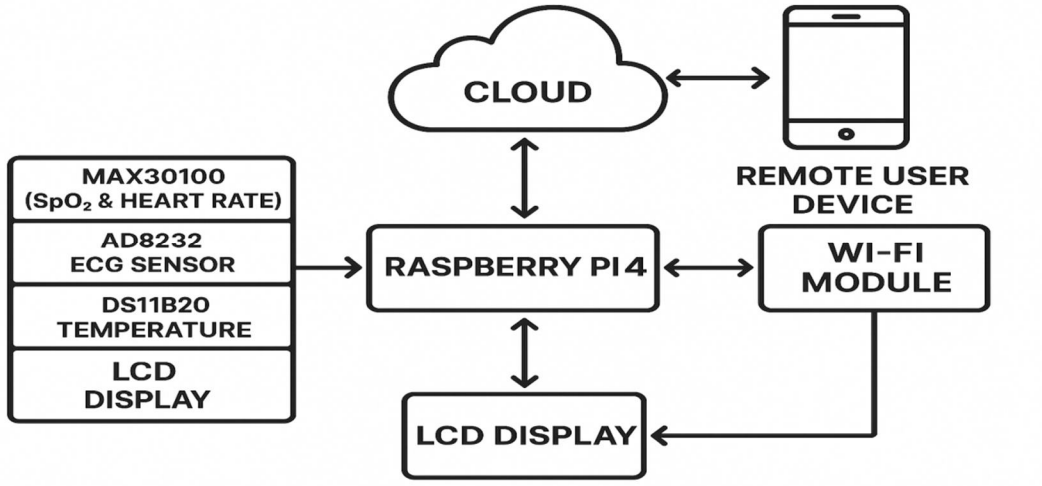
Abstract: ***This paper presents an IoT-based remote patient health monitoring system designed using Raspberry Pi 4 Model B. The system integrates MAX30100 (pulse oximeter and heart rate), AD8232 (ECG), and DHT11 (temperature and humidity) sensors to collect vital signs. A 16x2 LCD display is used for real-time visualization. Data is uploaded to ThingSpeak for cloud monitoring, while alerts are triggered using Twilio (SMS) and Mailgun (email). A Random Forest machine learning model is implemented in Python to detect anomalies in patient vitals, enabling early alerts. The project demonstrates a low-cost, scalable, and intelligent remote healthcare solution.***
Keywords: IoT, Raspberry Pi, Patient Monitoring, MAX30100, AD8232, DHT11, ThingSpeak, Twilio, Mailgun, Random Forest.

I. INTRODUCTION

Remote patient health monitoring is a critical application of IoT and embedded systems in healthcare. With increasing demand for non-contact and home-based monitoring solutions, this project aims to develop a compact system capable of recording key vital signs and alerting caretakers in real time.

II. SYSTEM ARCHITECTURE

The system uses a Raspberry Pi 4 Model B as the central processing unit. Sensors including MAX30100 (for SpO2 and pulse), AD8232 (for ECG), and DHT11 (for temperature and humidity) are interfaced via GPIO and I2C pins. A 16x2 LCD displays current readings. Data is sent to ThingSpeak using Wi-Fi, and alerts are managed via Twilio (SMS) and Mailgun (email).



III. HARDWARE COMPONENTS

- Raspberry Pi 4 Model B (4GB)
- MAX30100 Pulse Oximeter and Heart Rate Sensor
- AD8232 ECG Sensor
- DHT11 Temperature and Humidity Sensor
- 16x2 LCD Display
- Jumper wires and Breadboard
- Power Supply

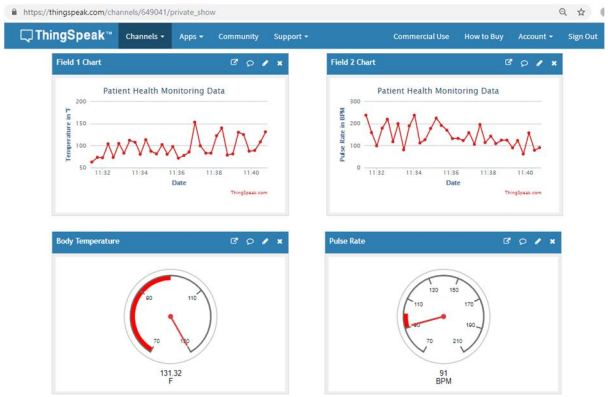
IV. MACHINE LEARNING MODEL

A Random Forest classifier is trained on labeled physiological data to detect abnormal patterns in heart rate, SpO2, ECG signal, and temperature. When the model predicts an anomaly, alerts are triggered through the integrated communication services.

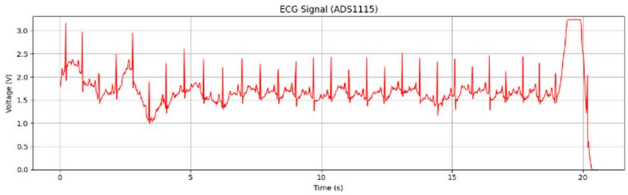
V. RESULTS

The system was tested with simulated patient data. Accurate detection of anomalies and successful delivery of alerts via SMS and email were observed. ThingSpeak plots confirmed continuous real-time data updates.

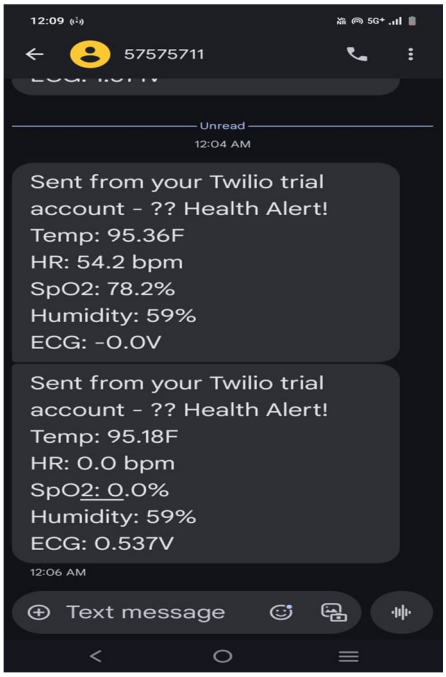
A. ThingSpeak result of vital parameters



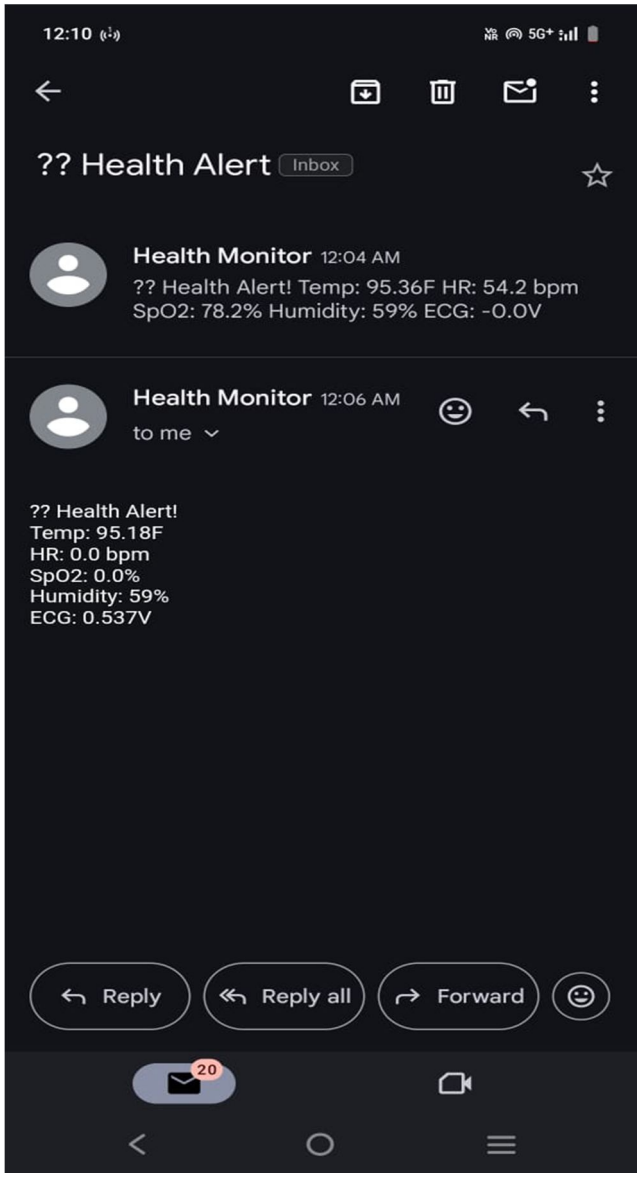
B. ECG Plotting



C. SMS Alert



D. Email Alert

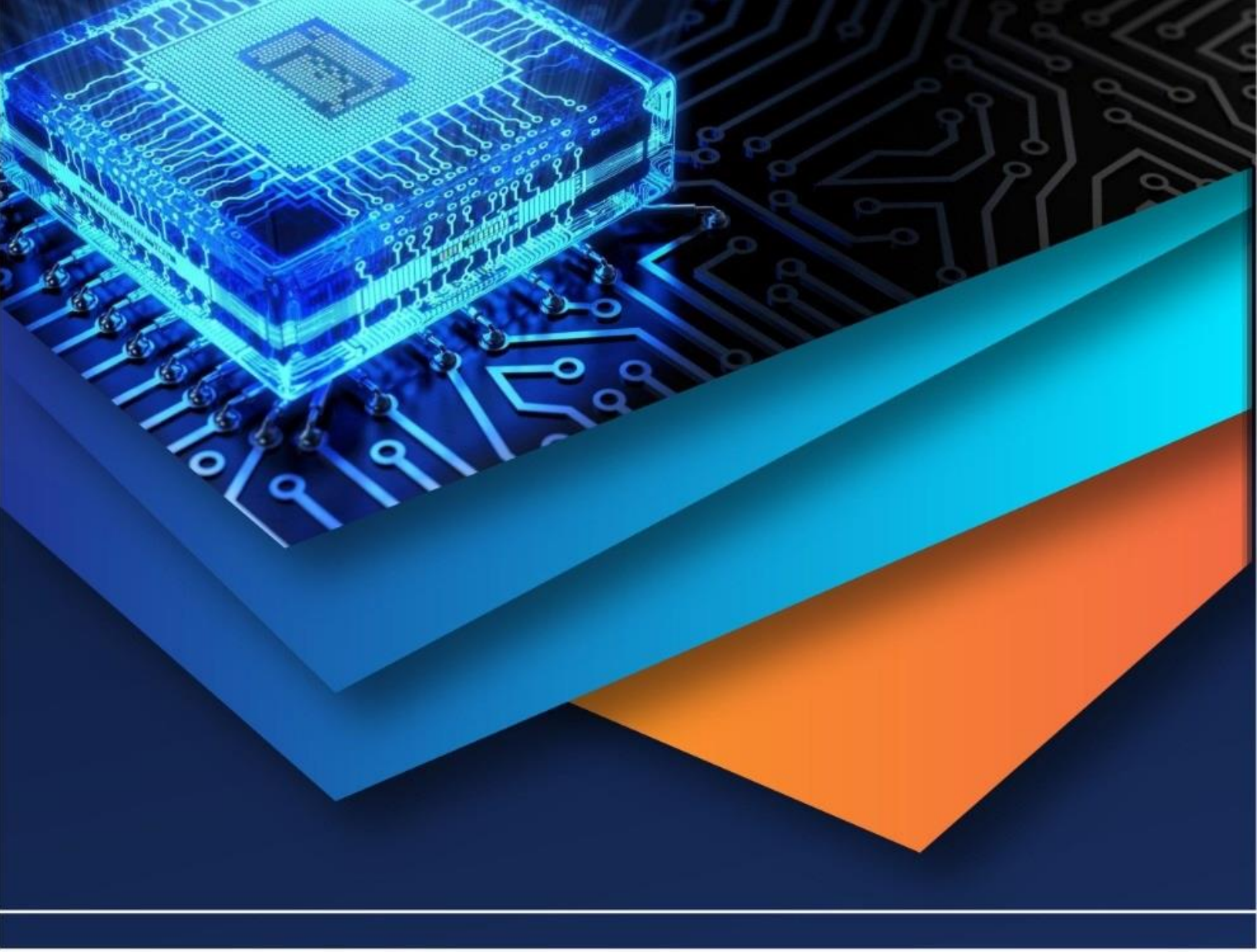


VI. CONCLUSION AND FUTURE WORK

The proposed system effectively integrates IoT and machine learning for smart patient monitoring. Future work includes integrating more sensors, improving model accuracy, and developing a mobile app for caregivers.

REFERENCES

[1] MAX30100 Pulse Oximeter Datasheet
[2] AD8232 ECG Sensor Datasheet
[3] DHT11 Temperature Sensor Datasheet
[4] ThingSpeak API Documentation
[5] Twilio SMS API Guide
[6] Scikit-learn: Random Forest Classifier



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