IoT-Based Remote ECG Monitoring with WhatsApp Alert System

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Introduction

Cardiovascular diseases (CVDs) are a leading cause of death worldwide, requiring continuous ECG monitoring for early detection and management. Traditional hospital-based ECG monitoring is time-consuming, limiting real-time patient care.

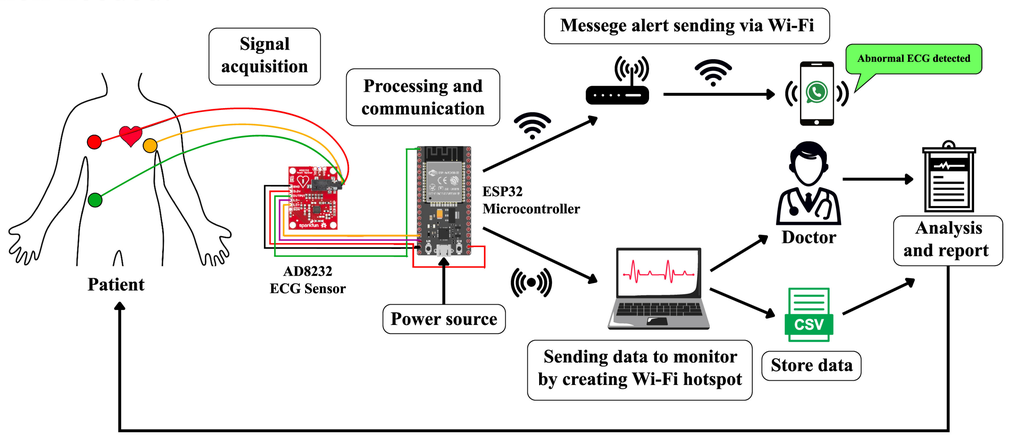
Real-time monitoring and timely alerts remain a challenge for remote healthcare settings. This project presents an IoT-based ECG monitoring system that continuously records ECG signals, processes them, and sends automated WhatsApp alerts in case of abnormalities.

Objectives

- Develop a portable, cost-effective ECG monitoring system.
- Enable real-time ECG visualization via a laptop.
- Store ECG data in CSV format for medical record-keeping.
- Implement WhatsApp alerts for abnormal heart readings.
- Ensure seamless connectivity using ESP32's WiFi capabilities.

Materials & Methods

The IoT-based remote ECG monitoring system consists of an AD8232 ECG sensor, an ESP32 microcontroller, and a laptop for real-time visualization. The AD8232 captures ECG signals, which the ESP32 processes, filters, and transmits via Wi-Fi. A Python script on the laptop visualizes the ECG and logs data in CSV format for analysis.For emergency alerts, if ECG readings become abnormal, the ESP32 connects to home Wi-Fi and sends a WhatsApp message to a doctor via CallMeBot API. This system enables continuous remote heart monitoring with real-time alerts, ensuring timely medical attention when needed.



Data Analysis & Filtering

AD8232 captures ECG, but raw signals contain noise. ESP32 applies a real-time filter to remove unwanted signals. Noise-free ECG signals are sent via serial port to Python. ECG peaks are analyzed for abnormal variations. Python script compares values against set thresholds. WhatsApp message sent if abnormality is detected.

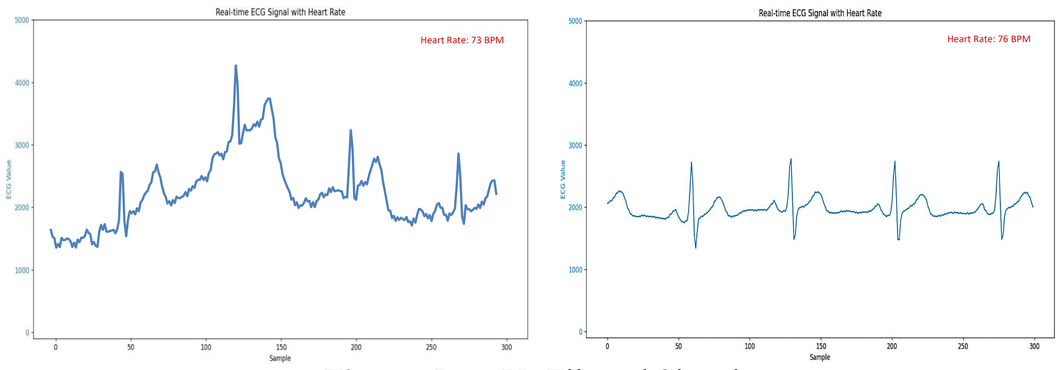


Figure: Raw Vs Filtered Signal

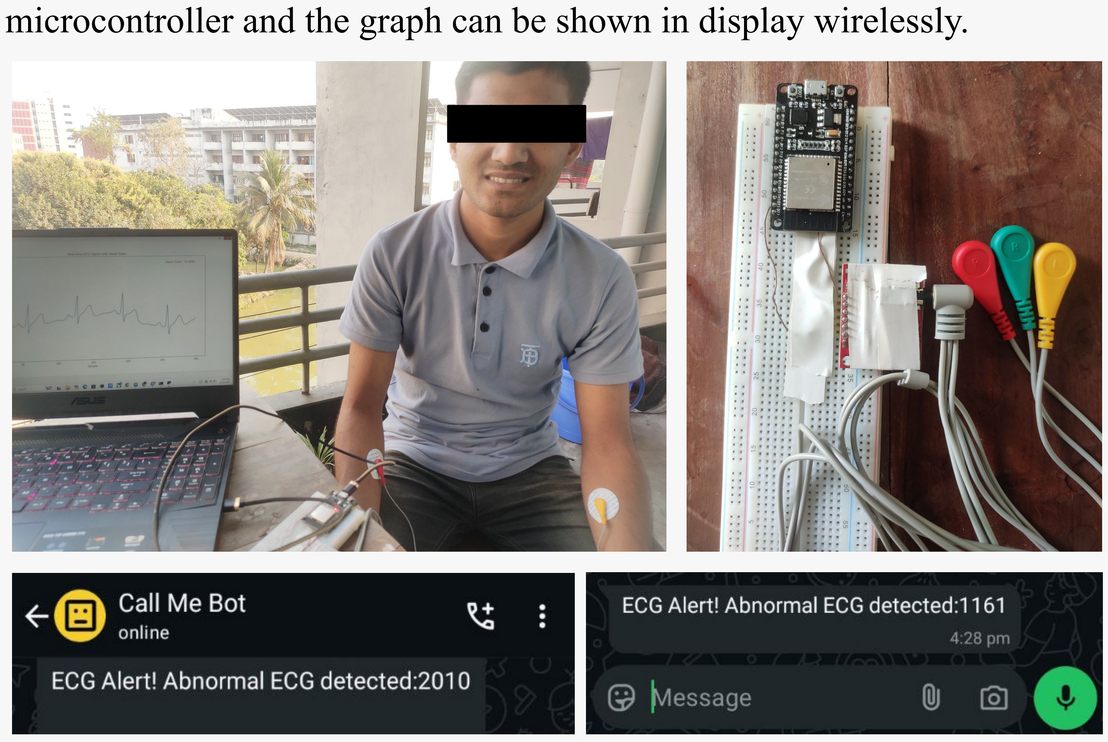
Results

The system successfully detects multiple ECG parameters (Heart Rate, HRV, R-Peak, PR Interval, QT Interval, Signal Quality) and sends alerts for abnormal ECG readings and critical ECG variations. WhatsApp alerts arrive within 5 seconds of anomaly detection.

Time	ECG Value	Heart Rate	HRV	R-Peak	PR Interval	QT Interval	Signal Quality
2/16/2025 16:23	2178	80	50	2178	120	380	0.95
2/16/2025 16:23	2220	80	50	2220	120	380	0.95
2/16/2025 16:23	2223	80	50	2223	120	380	0.95
2/16/2025 16:23	2186	80	50	2186	120	380	0.95
2/16/2025 16:23	2132	80	50	2132	120	380	0.95
2/16/2025 16:23	1986	80	50	1986	120	380	0.95
2/16/2025 16:23	1921	80	50	1921	120	380	0.95

Visual Representation

ECG signal is captured by AD8232 ECG sensor and transferred to ESP32 microcontroller and the graph can be shown in display wirelessly.



Conclusion

The IoT-based remote ECG monitoring system provides a real-time, low-cost, and portable solution for continuous heart health tracking. By integrating the AD8232 ECG sensor with an ESP32 microcontroller, the system visualizes ECG signals, logs data for analysis, and sends emergency alerts via WhatsApp when abnormalities are detected. The system's wireless connectivity allows remote monitoring, making it useful for ICU patients, home-based care, and rural healthcare settings. Future improvements could enhance signal filtering, AI-based arrhythmia detection, and GSM integration for greater accessibility.

References

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