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# Real-time IoT-Based Women Safety and Emergency Response System

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*Abstract* - **Ensuring women's safety during emergency situations remains a critical societal challenge, particularly when immediate access to mobile devices is not feasible. This paper presents a Real-time IoT-Based Women Safety and Emergency Response System designed using an ESP32 microcontroller integrated with a NEO-6M GPS module and SIM800L GSM communication. The proposed system enables instant alert generation through a dedicated panic button, automatically transmitting the user's real-time location to a cloud-based backend developed using the MERN (MongoDB, Express, React, Node.js) stack. Real-time communication is facilitated using Socket.IO, allowing alerts to be instantly visualized on role-based dashboards for administrators and responders. Additional features such as device registration, user authentication, and access control enhance system security and usability. Experimental evaluation demonstrates reliable GPS accuracy, minimal alert transmission delay, and stable dashboard responsiveness, validating the system's effectiveness for real-world deployment in campuses, workplaces, and public environments.**

***Keywords— Women safety, IoT alert system, GPS tracking, ESP32, SIM800L, Emergency response, Real-time monitoring, MERN stack.***

## I. INTRODUCTION

Women's safety has become a significant concern due to the increasing number of incidents reported in public spaces, workplaces, and educational institutions. In many emergency situations, victims may not have sufficient time or physical ability to access their mobile phones to seek help. Mobile-based safety applications further depend on factors such as battery availability, user interaction, and network connectivity, which may not be reliable during critical moments.

IoT-based wearable and hardware-assisted solutions provide an effective alternative by enabling rapid alert generation with minimal user involvement. Through the integration of GPS and GSM modules, IoT technologies support continuous monitoring and real-time data transmission. When combined with a cloud-based backend, emergency alerts can be received, processed, and displayed instantly for authorized responders.

In the proposed Real-time IoT-Based Women Safety and Emergency Response System, an ESP32 microcontroller integrated with a NEO-6M GPS module and SIM800L GSM module is used to transmit the user's real-time location to a cloud server upon activation of a panic button. The backend stores alert information and communicates with dashboards developed using React.js to display real-time tracking and alert notifications. The primary objective of the system is to provide a fast, reliable, and user-friendly emergency communication mechanism that functions effectively even without direct smartphone access.

### *A. Need for the System*

Women's safety challenges continue to increase in both urban and rural environments due to delayed emergency communication, inadequate monitoring mechanisms, and the absence of real-time tracking solutions. During emergencies, users may be unable to unlock their phones, open applications, or contact emergency numbers, resulting in delayed assistance.

Existing safety systems suffer from several limitations, including dependence on active mobile usage, lack of continuous real time tracking, absence of centralized monitoring authorities, and inconsistent alert delivery under

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poor network conditions. These limitations reduce the effectiveness of current solutions during critical situations.

A dedicated hardware-based emergency alert system overcomes these challenges by enabling instant alert activation through a single panic button. GPS integration ensures accurate location tracking, while SIM800L-based GSM communication allows alerts to be transmitted even without Wi-Fi connectivity. Additionally, a centralized web-based dashboard enables authorities and responders to monitor alerts and take timely action. Hence, an IoT-based emergency alert system is essential to provide reliable, location-aware, and rapid support for women during distress situations.

## II. PROBLEM STATEMENT

Women often face unexpected and unsafe situations where conventional safety mechanisms fail due to fear, time constraints, or limited access to mobile devices. In emergency scenarios, performing multiple actions such as unlocking a phone, opening an application, and triggering an alert may not be practical. These delays can significantly affect the effectiveness of emergency response.

Most existing safety solutions lack a dedicated hardware-based panic mechanism, automatic real-time location transmission, centralized monitoring, and structured role-based response management. The absence of these features results in delayed alerts, poor coordination among responders, and increased risk during critical situations.
Therefore, there is a need for a system that provides a simple one-button alert mechanism, accurate real-time GPS tracking, instant cloud communication, centralized monitoring through dashboards, and a secure and scalable backend infrastructure to ensure timely and effective emergency response.

### *A. System Overview*

The proposed system consists of an IoT-based emergency alert device integrated with an ESP32 microcontroller, a NEO-6M GPS module, and a SIM800L GSM module. When the panic button is pressed, the device captures the user's current geographic coordinates and transmits the alert to a cloud-based backend server.
The backend is developed using the MERN stack, where alert data is securely stored and processed. Real-time alert notifications are delivered to connected dashboards using Socket.IO, enabling administrators and authorized responders to view the user's live location on a map. Additional features such as device registration, user authentication, and role-based access control ensure secure and organized emergency handling. The system workflow ensures that every alert is recorded, monitored, and resolved efficiently.

### *B. Functional Flow*

The functional operation of the proposed system follows a structured sequence to ensure reliable emergency alert generation and response.

**Device Activation and Location Capture:** When the panic button is pressed, the ESP32 microcontroller is immediately activated. The device retrieves the latest valid GPS coordinates, including latitude, longitude, and timestamp, along with essential device information. The GPS module continuously monitors for a valid location fix to ensure accuracy.

**Alert Transmission:** Once the alert data is prepared, the system establishes a communication link and transmits the alert to the backend server using GSM-based HTTP communication through the SIM800L module. In the event of temporary communication failure, the device retries transmission to ensure successful delivery.

**Server Processing and Real-time Broadcast:** Upon receiving the alert, the backend server verifies the device identity, stores the alert details in the database, and assigns a unique alert identifier. The alert is then instantly broadcast to connected dashboards using Socket.IO, enabling real-time visibility for administrators and responders.

**Response and Alert Resolution:** Authorized responders acknowledge the alert through the dashboard interface and monitor the user's location updates in real-time. Once the situation is resolved, the alert status is updated and archived for future reference and analysis.

## III. WORKING PRINCIPLE

The proposed system operates by integrating IoT hardware with a cloud-connected backend to enable real-time emergency alerting and location tracking. The ESP32 microcontroller remains in an active monitoring state, continuously checking the status of the panic button while validating the availability of GPS coordinates.

When the panic button is pressed, the ESP32 immediately retrieves the most recent latitude and longitude values from the NEO-6M GPS module. An alert packet is then generated, containing the device identifier, GPS coordinates, timestamp, and alert status. This information forms the basis of the emergency notification.

The alert packet is transmitted to the backend server through the available communication channel. Wi-Fi is used when network connectivity is available, while the SIM800L GSM module serves as a reliable fallback by transmitting the alert using GSM communication in low or unstable internet conditions. This dual communication approach ensures dependable alert delivery.

Upon receiving the alert, the backend server validates the registered device, stores the alert data in the database, and broadcasts a real-time notification to connected dashboards using Socket.IO. Administrators and responders can view the user's location instantly on a map interface. The device continues to send periodic location updates until the alert is acknowledged and resolved, ensuring continuous monitoring throughout the emergency.

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## IV. HARDWARE COMPONENTS

The proposed system is built using reliable and cost-effective hardware components that collectively enable real-time emergency alert generation and communication.

**ESP32 Microcontroller:** The ESP32 serves as the central processing unit of the system. It monitors the panic button, processes GPS data, manages Wi-Fi communication with the backend server, and coordinates alert transmission.

**NEO-6M GPS Module:** The NEO-6M GPS module provides accurate real-time latitude and longitude information. It continuously updates the user's location, which is included in both cloud alerts and emergency messages.

**SIM800L GSM Module:** The SIM800L GSM module is used to send SOS alert messages containing the user's location and map link to pre-registered emergency contacts. This ensures that immediate assistance from relatives or nearby helpers is possible even when internet connectivity is unavailable.

**Push Button:** The push button functions as the emergency trigger. A single press activates the alert mechanism, minimizing the need for user interaction during distress situations.

**Power Supply Unit:** A stable power supply is provided to support the ESP32, GPS, and GSM modules, ensuring uninterrupted system operation during emergencies.

## V. BLOCK DIAGRAM

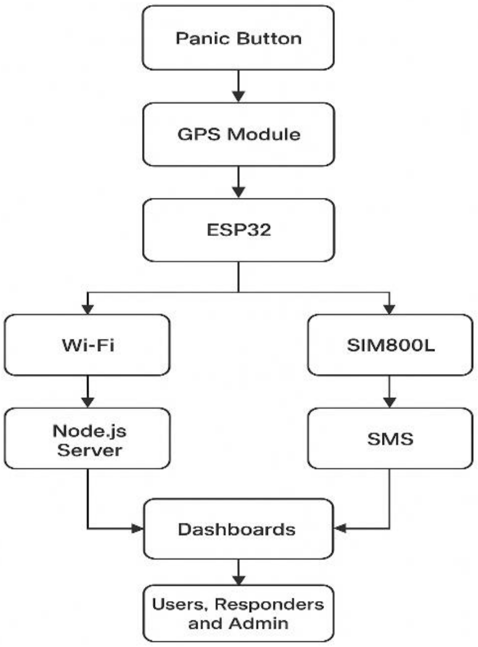


**Fig. 1.** Block diagram of the real-time IoT-based women safety and emergency response system

Figure 1 shows the block diagram of the real-time IoT-based women safety and emergency response system. The ESP32 microcontroller acts as the central control unit of the system. A NEO-6M GPS module is interfaced with the ESP32 to acquire the user's real-time geographical coordinates. A panic button connected to a digital input pin enables immediate activation during emergency situations.

When the panic button is pressed, the ESP32 retrieves the latest GPS coordinates and prepares an alert data packet. The system continuously monitors the user's location during the emergency to ensure updated tracking information. Wi-Fi communication is used to transmit the alert data to the cloud-based backend server, allowing real-time updates to be displayed on the monitoring dashboards.
In parallel, the SIM800L GSM module sends an SOS message containing the user's location along with a map link to pre-registered emergency contacts, enabling immediate assistance from relatives or nearby helpers even when internet connectivity is unavailable. Upon receiving the alert, the backend server verifies the device, stores the alert information, and updates the dashboards for users, responders, and administrators. This architecture ensures timely alert generation, continuous location monitoring, and prompt emergency response.

## VI. ADVANTAGES

The proposed real-time IoT-based women safety and emergency response system offers several practical advantages over conventional safety mechanisms.

**Instant Emergency Alerting:** The system enables users to trigger an emergency alert with a single panic button press, eliminating the need for mobile phone interaction during distress situations.

**Real-time Location Tracking:** GPS-based tracking provides accurate and continuous location updates, allowing responders and emergency contacts to locate the user quickly.

**Dual Communication Support:** Wi-Fi is used to transmit alert data to the cloud server, while the GSM module sends SOS messages with location map links to emergency contacts, ensuring alert delivery under varying network conditions.

**Role-Based Monitoring:** Separate dashboards for administrators and responders improve situational awareness, coordination, and efficient emergency handling.

**Scalable Cloud Architecture:** The cloud-based backend supports multiple devices and simultaneous alerts, making the system suitable for large-scale deployments.

**Low-Cost and Easy Deployment:** The use of affordable and widely available hardware components makes the system economical and easy to implement.

**User-Friendly Operation:** Minimal user interaction is required, as the entire emergency response process is initiated through a single button press.

## VII. RESULT AND DISCUSSION

The performance of the proposed real-time IoT-based women safety and emergency response system was evaluated through experimental testing focusing on GPS accuracy, alert transmission delay, dashboard responsiveness, and overall system reliability.

**GPS Performance Evaluation:** The NEO-6M GPS module was tested in different environments to measure location accuracy and lock time. In open areas, the system achieved faster GPS lock times with higher accuracy, while in semi-urban and indoor conditions, slightly increased lock times were observed. Despite this, the obtained accuracy remained sufficient for emergency tracking applications, ensuring reliable location identification during distress situations.

**Alert Transmission Delay Analysis:** Alert transmission performance was analyzed under varying network conditions. When Wi-Fi connectivity was available, alert data was transmitted to the backend server with minimal delay. The GSM module successfully delivered SOS messages containing location map links to emergency contacts even under weak signal conditions. The observed transmission delays remained within acceptable limits for emergency response scenarios.

**Dashboard Responsiveness:** The user, responder, and administrator dashboards were tested under continuous alert conditions. Real-time updates using Socket.IO demonstrated minimal latency, allowing alerts and location updates to be displayed almost instantly. Alert acknowledgment and resolution actions were reflected consistently across all dashboards.

**System Stability and Reliability:** The system was subjected to repeated alert generation and extended operation tests. No data loss was observed, and stable communication was maintained throughout testing. The combined use of Wi-Fi-based server communication and GSM-based SOS messaging enhanced system reliability across different network environments.

Overall, the experimental results confirm that the proposed system delivers reliable performance, timely alert transmission, and stable real-time monitoring, making it suitable for deployment in real-world safety-critical environments.

## VIII. CONCLUSION

This paper presented a real-time IoT-based women safety and emergency response system designed to provide quick and reliable assistance during critical situations. By integrating an ESP32 microcontroller with GPS and GSM communication modules, the system enables accurate location tracking and immediate alert generation through a single panic button press. Wi-Fi communication ensures real-time data transmission to the cloud server, while GSM-based SOS messaging delivers location details to emergency contacts when internet connectivity is unavailable.

The cloud-based backend and role-based dashboards allow administrators and responders to monitor alerts and track user locations efficiently. Experimental evaluation demonstrated low alert transmission delay, acceptable GPS accuracy, and stable real time dashboard performance. Due to its low cost, scalability, and ease of deployment, the proposed system is suitable for use in educational institutions, workplaces, and public environments. Future enhancements may include mobile application integration, geofencing-based alerts, and advanced analytics to further improve system effectiveness.

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