

IoT Based Women Safety Monitoring and Emergency Response System using ESP32

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Abstract:

In the contemporary socio-technical landscape, ensuring the personal safety of vulnerable demographics remains a paramount global challenge. Traditional personal safety applications rely heavily on smartphone integration, demanding multi-step user interactions which consume critical seconds during a high-stress emergency. To address these vulnerabilities, this project proposes "She-Mesh Pro," a standalone, IoT-enabled rapid response system featuring a dual-action tactile interface and localized acoustic deterrence. The core innovation lies in its highly reliable, dual-state triggering mechanism. Utilizing a hardware-debounced tactile push-button interfaced with an ESP32-WROOM microcontroller, the system evaluates the temporal duration of user engagement. A "Short Press" autonomously initiates a high-priority, silent interrupt sequence. Without requiring smartphone tethering, the onboard SIM800L GSM module dispatches urgent SMS alerts containing real-time geolocations acquired via the NEO-6M GPS module, followed by an automated voice call to pre-configured emergency contacts. Conversely, a "Long Press" (exceeding 2000 milliseconds) instantly activates a localized acoustic deterrence protocol—driving a passive buzzer via Pulse Width Modulation (PWM) to emit a high-decibel, sweeping police siren designed to induce psychological panic in an aggressor and attract immediate public attention. Furthermore, the system hosts a local captive portal via an 802.11 b/g/n WiFi Access Point, allowing users to securely manage their emergency contacts through a mobile-friendly web dashboard. The resulting prototype offers a robust, multi-tiered safety net combining silent global telemetry with localized acoustic defense.

Keywords: Personal Safety System, IoT-Based Emergency Device, ESP32-WROOM-32 Microcontroller, GSM Communication using SIM800L GSM Module, GPS Tracking with NEO-6M GPS Module

1. Introduction

The advent of the 21st century has been characterized by an unprecedented paradigm shift in human-computer interaction, transitioning from static, localized computing to pervasive, ubiquitous networking. This evolution is fundamentally driven by the Internet of Things (IoT) and Embedded Systems, domains that have collaboratively blurred the boundaries between the physical and digital realms. To fully comprehend the architectural philosophy and the socio-technical necessity of the "She-Mesh" project, it is imperative to deeply explore the historical context, the underlying physics of the hardware, and the theoretical frameworks governing these interconnected domains.

2. Literature Review

Due to the growing need to safeguard vulnerable people, including women, children, and the elderly, personal safety systems have received a lot of attention lately. Smartphone-based apps that notify emergency contacts in hazardous circumstances were the foundation of many early safety solutions. Applications like Safe and Safetipin, for instance, offer location sharing capabilities, SOS notifications, and GPS tracking. These apps provide helpful safety features, but they rely a lot on smartphones, internet access, and user input, which could cause delays in an emergency. IoT-based safety gadgets that operate autonomously without cell phones have been the subject of recent study.

Microcontroller platforms such as the ESP32-WROOM-32 have gained popularity because of their low power consumption, high processing power, and integrated WiFi. Real-time processing and connectivity with external modules are made possible by these controllers. Emergency alert systems that integrate GPS tracking via the NEO-6M GPS Module with GSM communication via the SIM800L GSM Module have been proposed in a number of studies. In an emergency, these devices can broadcast position coordinates and SMS notifications to designated contacts.

Researchers have also looked into wearing or portable safety devices that have panic buttons that instantly sound a warning. Some designs include alarm buzzers or sirens to attract public attention and deter potential attackers. However, many existing systems only provide a single alert mechanism and lack intelligent triggering features or multi-layered safety responses.

As a result, new developments focus on multifunctional safety systems that incorporate wireless communication, local deterrence techniques, and real-time position tracking. By including a dual-action trigger mechanism that combines silent emergency communication via GSM with an acoustic deterrence alert and provides contact management via a WiFi-based web interface, the proposed She-Mesh Pro system expands on these advancements. When compared to traditional safety applications and simple panic warning systems, this method enhances response speed, dependability, and overall user safety.

3. Case and Methodology

When victims are unable to swiftly access smartphones or handle complicated applications, personal safety events frequently take place. Even a few seconds of delay can drastically lower the likelihood of getting aid in a timely manner in many emergency situations, such as harassment, stalking, or violent threats. Emergency alert features are offered by current smartphone-based safety apps like b Safe and Safetipin, but users must unlock their phones, launch the apps, and manually trigger the alarm. In high-stress circumstances, this multi-step interaction might not be feasible.

The She-Mesh Pro system is made as a stand-alone safety device that can immediately initiate emergency actions with a single button press in order to get over these restrictions. The ESP32-WROOM-32 microcontroller, SIM800L GSM Module for communication, and NEO-6M GPS Module for real-time location tracking are examples of embedded hardware components that are integrated into the system. This gadget ensures quick reaction and enhanced personal protection without the need for cell phones by offering both audible deterrence and silent emergency notifications.

An embedded hardware–software integration technique is used in the development of the suggested She-Mesh Pro system to guarantee a dependable and quick personal safety reaction. The ESP32-WROOM-32 microcontroller serves as the primary processing unit and is the focal point of the overall system architecture. It controls the communication between several hardware modules, including the buzzer, push-button interface, GPS module, and GSM module. The ESP32 handles user input, manages system functions, and plans emergency communication activities.

A hardware-debounced tactile push button is used to build a dual-action trigger mechanism in the first step of the process. The microcontroller computes the length of the press while continuously monitoring the button's condition. The emergency communication sequence is triggered if the button is pressed momentarily, which the system interprets as a brief press. The audio alarm system is activated if the button is pressed for more than 2000 milliseconds.

The NEO-6M GPS Module provides the system with real-time geographic coordinates during the emergency communication process. The ESP32 then processes the location data before sending it via the SIM800L GSM Module. The GSM module sends SMS alerts containing the GPS coordinates to pre-configured emergency contacts and also initiates an automatic voice call to notify them about the emergency situation.

The system has an acoustic discouragement mechanism for instantaneous local protection. When a long press is detected, the ESP32 activates a passive buzzer using Pulse Width Modulation (PWM). This generates a loud police-siren–like sound that can attract nearby people and psychologically deter potential attackers. The system also offers a configuration interface based on Wi Fi. The ESP32 runs a captive web portal and establishes a local WiFi access point. Without the need for a specific mobile application, users can simply add, edit, or remove emergency contact numbers using our mobile-friendly web dashboard.

The prototype system is then put together and put through tests to see how well it works in practical situations. The testing process focuses on response time, GPS accuracy, GSM message delivery reliability, and the effectiveness of the alarm system, ensuring that the device functions efficiently as a rapid-response personal safety solution.

4. Results & Analysis

The ESP32-WROOM-32 microcontroller combined with the SIM800L GSM Module and the NEO-6M GPS Module allowed for the successful implementation of the ****She-Mesh Pro**** prototype. The dual-action push button correctly identified both short and lengthy presses, according to testing. While the lengthy push generated a loud siren through the buzzer to draw attention from others nearby, the short press successfully prompted SMS notifications with real-time GPS location and started an automatic call to emergency contacts. The system proved to be efficient in emergency scenarios because to its prompt response, dependable communication, and precise location monitoring.

5. Conclusion

The She-Mesh Pro system uses IoT-based technologies to provide a useful and efficient personal safety solution. The technology guarantees quick action in emergency scenarios by combining a stand-alone emergency alarm mechanism with real-time GPS monitoring and GSM communication. The dual-action button increases the likelihood of prompt assistance by offering both powerful sonic deterrence and silent emergency messages. Therefore, by offering a dependable and user-friendly emergency response tool, the suggested system can greatly improve personal safety, especially for women and other vulnerable people.

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