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IoT-Powered Emergency Button for Women's Safety

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ABSTRACT

In a world where women's safety remains a major concern, there is an urgent need for proactive solutions that can provide real-time assistance during emergencies. Traditional mobile applications and emergency contact numbers, while useful, rely heavily on user interaction and internet connectivity, which may not always be accessible in high-stress situations. This project proposes a practical, standalone, and IoT-based solution titled "IoT Powered Emergency Button for Women Safety", designed to address these limitations.

The system consists of a compact and wearable emergency switch built using an ESP8266/ESP32 microcontroller, a NEO-6M GPS module, and a SIM800L GSM module. A simple push button serves as the trigger. When pressed, it activates the system to retrieve real-time location coordinates and send an SMS alert containing a Google Maps location link to pre-configured emergency contacts. A buzzer or LED indicator provides immediate feedback to the user, confirming successful transmission of the alert. The system also integrates Blynk IoT platform support, enabling cloud-based monitoring, logging, and app-based notifications.

The prototype was successfully tested under various real-world conditions, including weak GPS signals and GSM network fluctuations. It demonstrated high reliability in sending alerts, maintaining GPS accuracy, and functioning effectively even without internet access. The system is energy-efficient, battery-powered, and fully portable, making it suitable for everyday use as a wearable accessory.

This project contributes to the domain of smart safety systems by offering a low-cost, independent, and easy-to-use device for women’s personal security. Future improvements such as two-way communication, battery monitoring, fall detection, and mobile app integration are also discussed, paving the way for a scalable, real-world deployment. The integration of embedded systems and IoT technologies into safety applications proves to be a powerful step toward building a safer, more responsive environment for women.

Keywords: IOT, Safety, Button

I. INTRODUCTION

1.1 Introduction

Women’s safety is a major societal concern that continues to affect millions of lives across the globe. While awareness and advocacy efforts have increased, the rate of crimes such as harassment, stalking, and assault against women remains alarmingly high. Traditional safety measures often fall short in providing immediate and effective responses in real-time crisis situations. In light of these challenges, technology is increasingly being explored as a medium to support women's safety.

The evolution of Internet of Things (IoT) technologies presents a unique opportunity to create responsive, wearable devices that can offer instant emergency support. IoT allows physical objects to sense, collect, and share data, making it ideal for developing systems that respond automatically to danger. This project focuses on designing an IoT-powered emergency button, a discreet, wearable device that, when triggered, sends an alert containing the user’s real-time GPS location to pre-registered contacts and nearby authorities.

By enabling rapid, location-aware emergency response and offering cloud-based data storage, this system aims to serve as a reliable safety tool for women in distress, helping reduce response times and possibly preventing further harm.

1.2 Objectives

The primary objectives of this project are:

- To design and develop a wearable IoT-based emergency button for women's safety.
- To enable real-time GPS tracking and instant alert transmission upon activation.
- To integrate cloud-based services for secure data access and monitoring.
- To ensure low power consumption for long-term use.
- To allow future expansion with features such as audio recording, vibration feedback, fall detection, and mobile app integration.

II. LITERATURE REVIEW

The literature survey of some existing systems is done:

[1] Women safety device and application. In this paper an ARM controller and Android application are used in which both the device and the smartphone are synchronized using Bluetooth, hence both can be triggered independently. It can record audio for further investigation and can give an alert call and message to the pre-set contacts with the instant location every 2 minutes and can be tracked live using the application. Hidden camera detector is also a distinct feature used which ensures privacy.

[2] A mobile-based women safety application (I safe Apps). In this paper, mobile-based application (I safe apps) is developed with the Android support to know whether a woman is safe. It gives the location of the woman in danger by giving fake phone calls, video forwarding, location and first-aid information.

[3] Advanced Security system for women. The paper proposes an automated highly reliable women security device which consists of advanced sensors embedded in a wearable dress. It consists of advanced sensors and ATMEGA8 micro controller with Arduino tool which keep user under observation at all the time. It monitors the heartbeat rate, temperature and vibration in the body through sensors to check for uneasy situations.

[4] Woman safety, the system has different sensors like heartbeat sensor, temperature sensor, accelerometer sensor for detecting the heartbeat, temperature and sudden change in motion of the user. GPS and GSM which will help to detect the location of the device and to send an alert message to guardians, relatives and police station.

III. SYSTEM REQUIREMENTS

3.1 Hardware Requirements

To develop the wearable IoT device, the following hardware components are required:

Table 3.1 Hardware Requirements for IoT Emergency Button System

Component	Description & Purpose
Microcontroller (ESP8266 / ESP32)	Acts as the brain of the system, controlling all input/output operations, GPS and GSM modules. ESP32 is preferred for advanced capabilities like dual-core processing, Wi-Fi, and Bluetooth.
GPS Module	Provides real-time latitude and longitude coordinates. It communicates with the microcontroller via serial communication. Essential for tracking the user's exact location in an emergency.
GSM Module	Responsible for sending SMS alerts to emergency contacts. It operates using AT commands and a SIM card to connect to mobile networks.
Emergency Push Button	Physical switch that the user presses in distress. Its state change is monitored by the microcontroller to trigger the SOS system.
Battery (Li-ion 3.7V or 9V)	Portable and rechargeable power source for the device. Ensures continuous operation. Often combined with a charging module such as TP4056.

Component	Description & Purpose
Voltage Regulator (AMS1117 / LM2596)	Used to regulate input voltage to a safe level for sensitive modules like SIM800L, which require a stable 3.7V–4.2V.
LED Indicator	Indicates the working state (e.g., GPS lock, message sent). Visual confirmation improves usability.
Vibration Motor	Provides haptic feedback to reassure the user that the alert has been successfully triggered.

3.2 Software Requirements

Alongside the physical components, several software tools and environments are required to code, test, debug, and connect the IoT system with cloud services and APIs.

Table 3.2 Software Requirements for Programming and Integration

Software/Tool	Functionality
Arduino IDE	Primary development environment for writing and uploading code to ESP32/ESP8266.
Embedded C / Arduino C++	Programming language used to write logic for hardware control.
AT Commands	Set of instructions used to control GSM module (e.g., sending SMS, checking signal).
Serial Monitor/Plotter	Real-time interface to debug GPS and GSM data flow from modules.
Cloud Platform (e.g., Firebase / ThingSpeak)	To store, monitor, and visualize GPS data and alert messages remotely.
Google Maps API (optional)	Converts latitude and longitude into map visuals for web/mobile application dashboards.
Mobile App (future enhancement)	For emergency contacts or guardians to monitor alerts, respond, and view user’s location.

IV. SYSTEM DESIGN AND IMPLEMENTATION

4.1 Introduction

Designing an effective safety alert system for women requires a deep understanding of embedded system integration, real-time communication, sensor behavior, and user experience in emergency scenarios. This chapter elaborates on the step-by-step implementation and system design of the proposed IoT-based emergency switch. It discusses how the system functions, the structure of data flow, hardware integration, and the logical algorithm that enables real-time emergency response.

The goal of this system is to create a wearable and user-friendly safety device that immediately communicates the user’s real-time location to emergency contacts via GSM-based SMS. When triggered by a physical button, the system activates GPS tracking, retrieves location data, and transmits it using a GSM module—ensuring fast, reliable, and offline-compatible alerting. This is particularly crucial in situations where the victim has no access to a smartphone or internet services.

The system combines components such as ESP32/ESP8266, SIM800L GSM module, NEO-6M GPS module, and a push-button interface, assembled in a compact wearable form. Real-time responsiveness, discreet operation, and low power consumption are key goals of the implementation.

The following sections present the complete breakdown of system design: from logical flow and block diagram to testing, algorithm, and packages used.

4.2 Design of Proposed System

The system is designed to function in a real-time emergency environment, enabling the victim to alert family members or law enforcement authorities by pressing a simple button. The alert contains GPS coordinates (latitude and longitude) and is sent via SMS using the GSM module.

A vibration motor or LED indicator provides confirmation to the user that the alert has been sent.

4.2.2 Core Functional Objectives:

- **Emergency Trigger:** Easily accessible and fast-responding button.
- **Real-Time GPS Location:** Accurate tracking using satellite data (NEO-6M).
- **Immediate Alert Transmission:** SMS-based communication for maximum reach.
- **User Feedback:** Visual or tactile confirmation using LED/vibration.
- **Compact & Low Power:** Usable as a wristband or pendant for continuous use.

4.3 Data Flow Diagram

The Data Flow Diagram (DFD) illustrates the logical interaction between system components during an emergency event. It helps in visualizing how information flows from the trigger event (button press) through the various functional units of the system, ultimately reaching the recipient via SMS. This model represents a Level 1 DFD, which shows the core processes without diving into code-level detail.

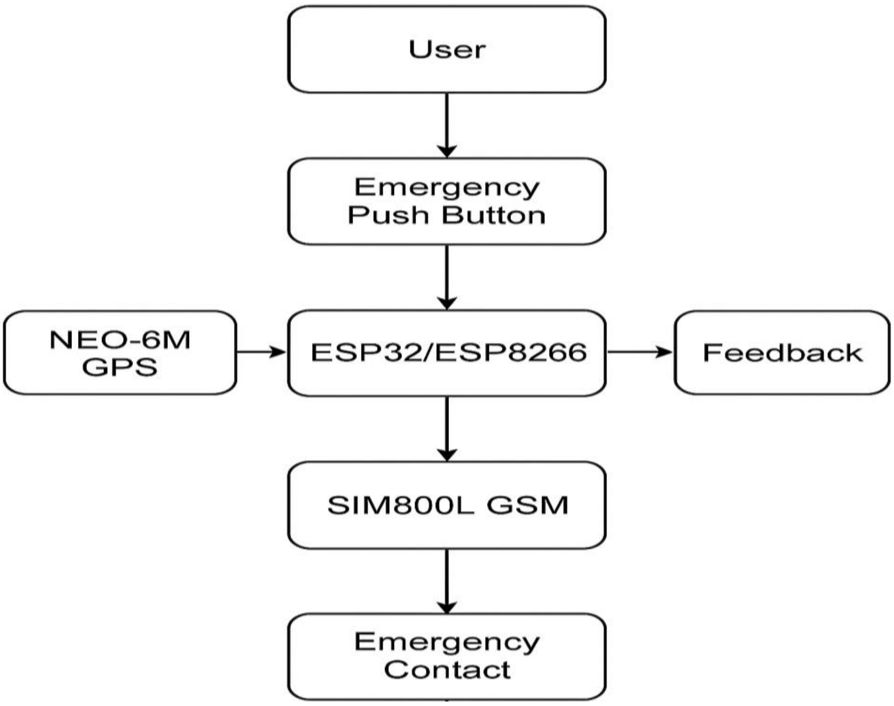


Figure 4.1: Functional Data Flow of IoT-Based Emergency Alert System

4.4 System Design
The figure 4.1 shows block diagram which gives you the overview of the proposed system. The brief description given below.

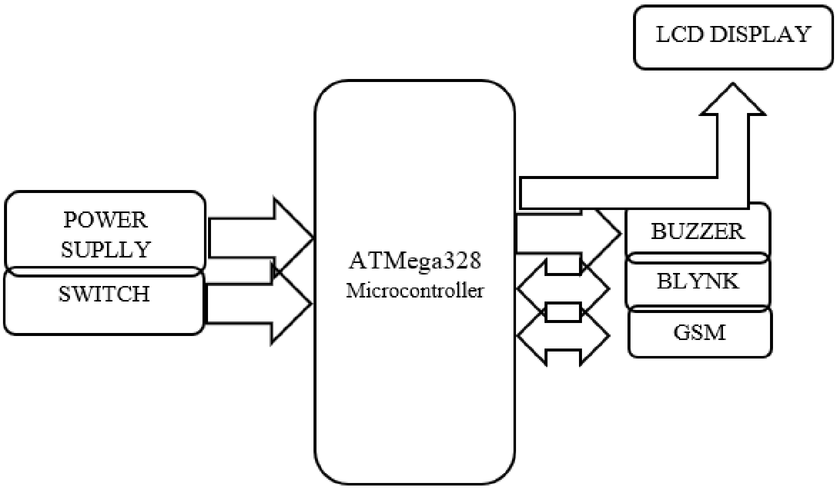


Figure 4.1: Block Diagram of the Proposed Emergency Switch System

To complete our project, we require some software as well as some hardware.

Required Software:

1. ARDUINO IDE

Required Hardware:

1. ARDUINO NANO
2. 9V BATTERY
3. GPS MODULE
4. GSM MODULE
5. BUZZER

4.6 Communication
Communication is the activity of conveying information through the exchange of messages, or information. The system which is to displays the next station information. To establish the communication between the station and Train we using RF communication system.
4.6.1 Communication System

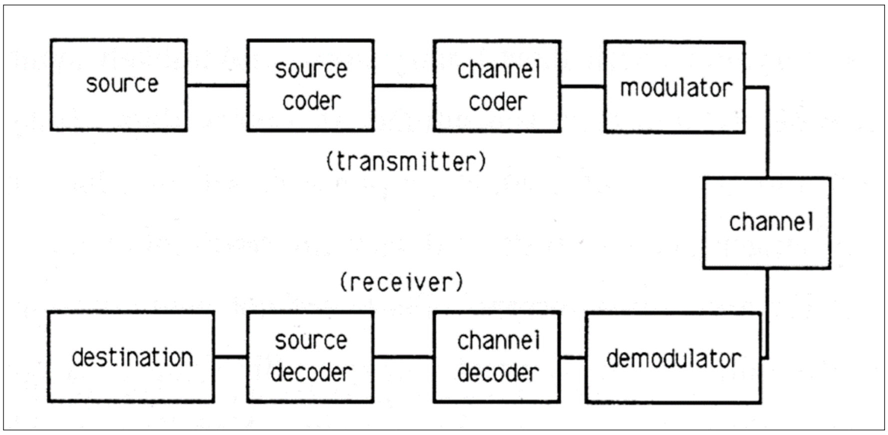


Figure 4.2: Block diagram of Communication System

A GSM module assembles a GSM modem with standard communication interfaces like RS-232 (Serial Port), USB etc., so that it can be easily interfaced with a computer or a microprocessor/microcontroller based system.

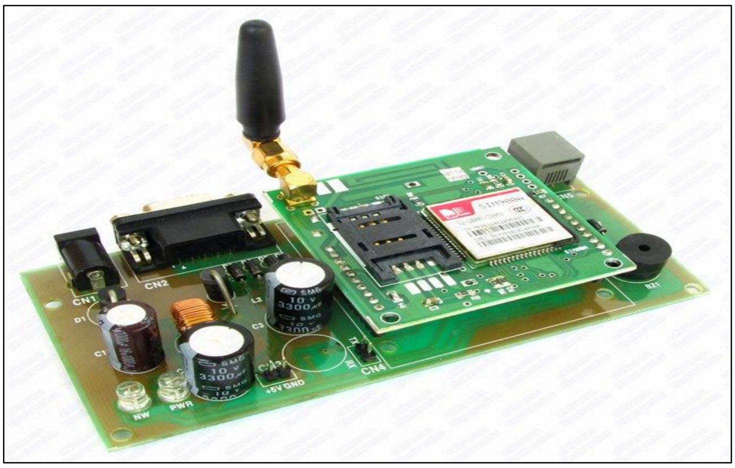


Figure 4.3: GSM Module (With serial converter port)

Mobile Station (Cell phones and SIM)

A mobile phone and Subscriber Identity Module (SIM) together form a mobile station. It is the user equipment that communicates with the mobile network. A mobile phone comprises of Mobile Termination, Terminal Equipment and Terminal Adapter.

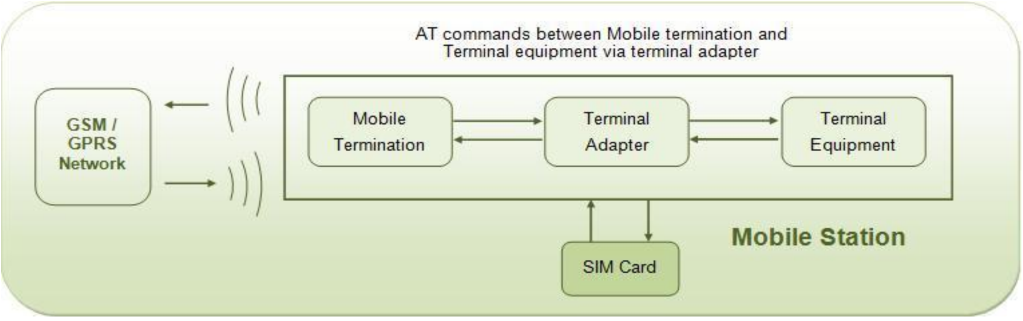


Figure 4.4: Mobile station and communication network

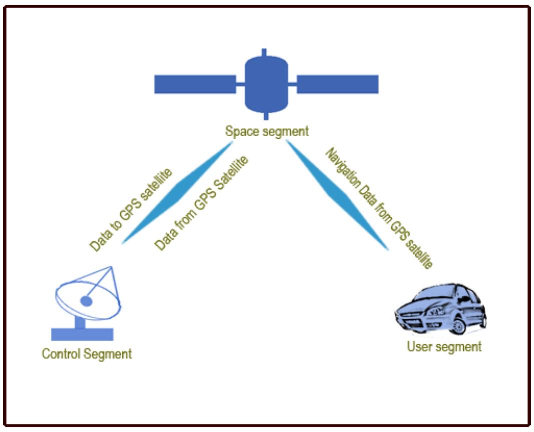
4.6.4 GPS Technology:

PS technology became a reality through the efforts of the American military, which established a satellite-based navigation system consisting of a network of 24 satellites orbiting the earth. GPS is also known as the NAVSTAR (Navigation System for Timing and Ranging).

GPS works all across the world and in all weather conditions, thus helping users track locations, objects, and even individuals! GPS technology can be used by any person if they have a GPS receiver.

Structure of GPS

The GPS system comprises of three parts: Space segment, User segment and Control segment. The diagram of the structure of GPS is given below.



- **Space segment:** The satellites are the heart of the Global positioning system which helps to locate the position by broadcasting the signal used by the receiver. The signals are blocked when they travel through buildings, mountains, and people.
- **User segment:** This segment includes military and civilian users. It comprises of a sensitive receiver which can detect signals (power of the signal to be less than a quadrillionth power of a light bulb) and a computer to convert the data into useful information. GPS receiver helps to locate your own position but disallows you being tracked by someone else.
- **Control segment:** This helps the entire system to work efficiently. It is essential that the transmission signals have to be updated and the satellites should be kept in their appropriate orbits.

Working

The GPS satellites rotate twice a day around the earth in a specific orbit. These satellites transmit signal information to earth. This signal information is received by the GPS receiver in order to measure the user's correct position. The GPS receiver compares the time a satellite transmits the signal with the time the signal is received. The time difference calculated enables us to know the distance of the satellite. By measuring the distance of few more satellites, the user's position can be verified and displayed on the unit's electronic map.

To measure 2D position and track movement, the GPS receiver must lock the signal of three satellites. The receiver can measure 3D position (latitude, longitude and altitude) if the GPS receiver locks the signal of four or more satellites. On determining the position of the user, the unit of GPS can measure speed, trip distance, bearing, distance to destination, tack, time of sunrise and sunset, etc.

4.8 HARDWARE IMPLEMENTATION

A power supply (sometimes known as a regulated power supply unit or RPSU) is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

4.8.1 Block diagram

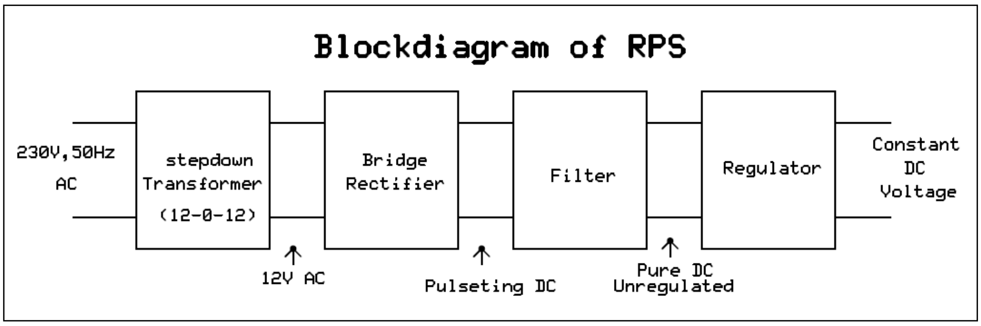
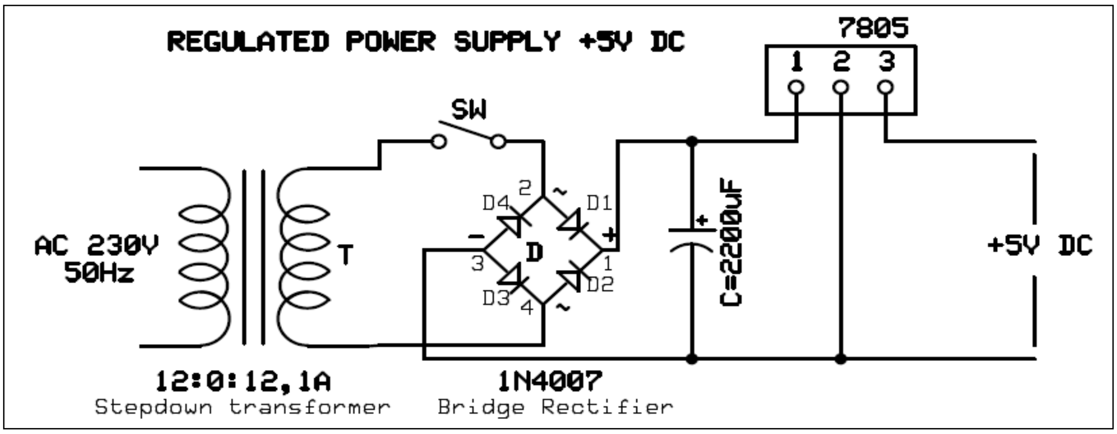


Figure 4.8.2: Block diagram of Regulated Power supply Unit

- The first section is the transformer. The transformer steps up or steps down the input line voltage and isolates the power supply from the power line.
- The rectifier section converts the alternating current input signal to a pulsating direct current. However, as you proceed in this chapter you will learn that pulsating dc is not desirable.
- For this reason a filter section is used to convert pulsating dc to a purer, more desirable form of dc voltage.
- 78xx chip family gives different output voltage as regulator. The last numbers in the chip code tells the output voltage.

4.8.2 Circuit description



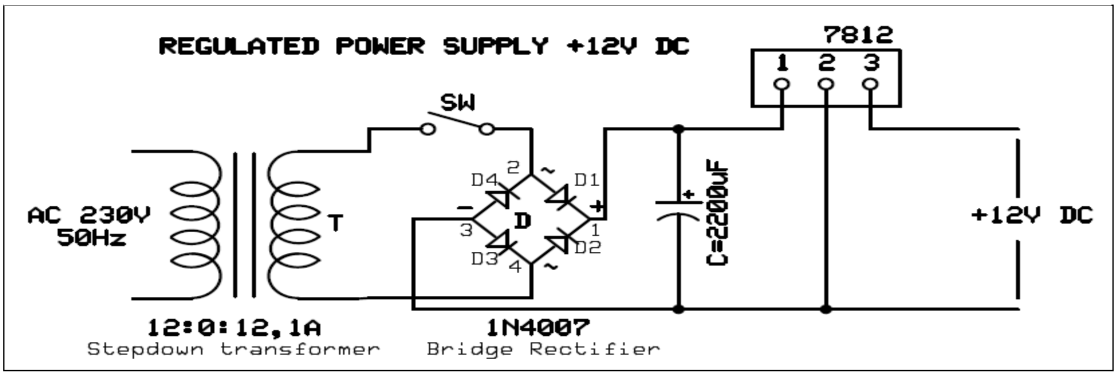


Figure 4.8.2.1: Schematic/Circuit diagram of +12V RPS

V. RESULTS AND DISCUSSION

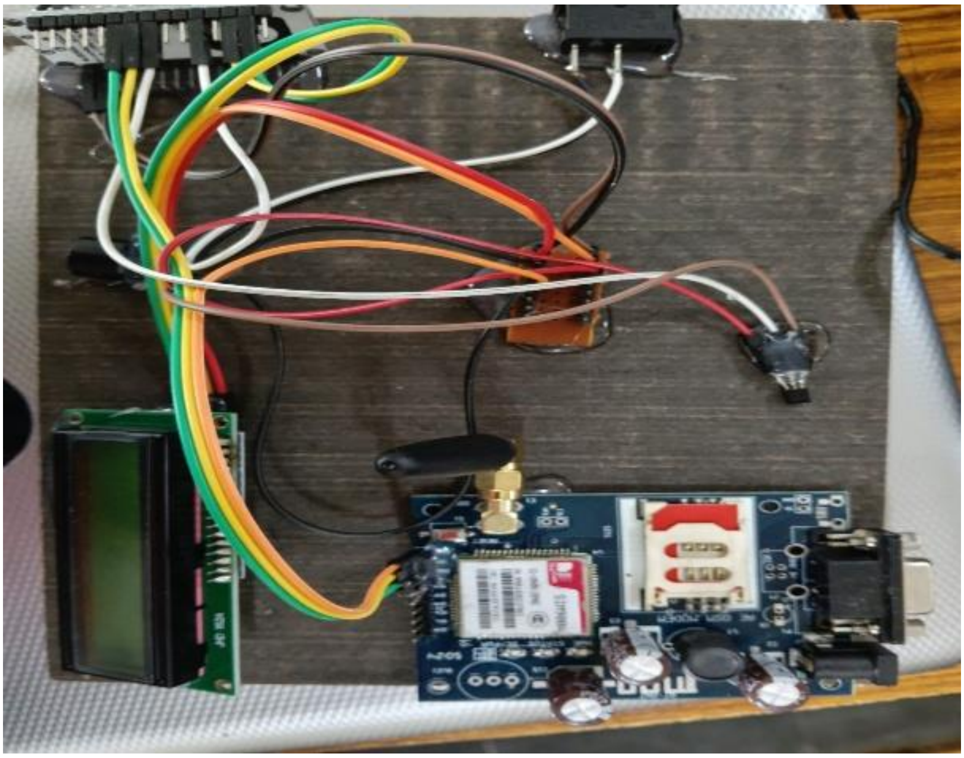
The objective of this project was to design and implement a real-time, reliable, and portable emergency alert system specifically aimed at enhancing women's safety using IoT technology. The device functions independently of a smartphone and can operate even in the absence of internet connectivity, making it particularly suitable for rural or high-risk environments. The final prototype was developed using embedded hardware modules and software tools and was subjected to several rounds of real-world testing. This chapter documents the key results observed, and provides a critical discussion on system performance, accuracy, and scope for improvement.

5.1 Hardware Assembly and Functionality

The developed hardware was neatly mounted on a wooden base to create a stable and testable prototype. The main components—SIM900A GSM module, NEO-6M GPS module, ESP8266 microcontroller, buzzer, push button, and I2C-based LCD display—were connected using jumper wires. Each module was tested individually before integration to ensure component-level correctness.

From the images captured during the implementation phase, it is clear that the wiring and component layout were handled carefully. The GSM module was tested using a working SIM card to ensure that SMS commands executed correctly using AT commands. The GPS module, on the other hand, was tested both outdoors and indoors. Outdoor GPS reception was fast and stable, while indoor testing faced occasional delays in signal acquisition.

The LCD served its purpose effectively, providing visual feedback to the user such as "System Normal" during idle mode and “Emergency Alert” when the button was pressed. This real-time user feedback mechanism enhances usability, ensuring the user is aware of the system’s state at all times.

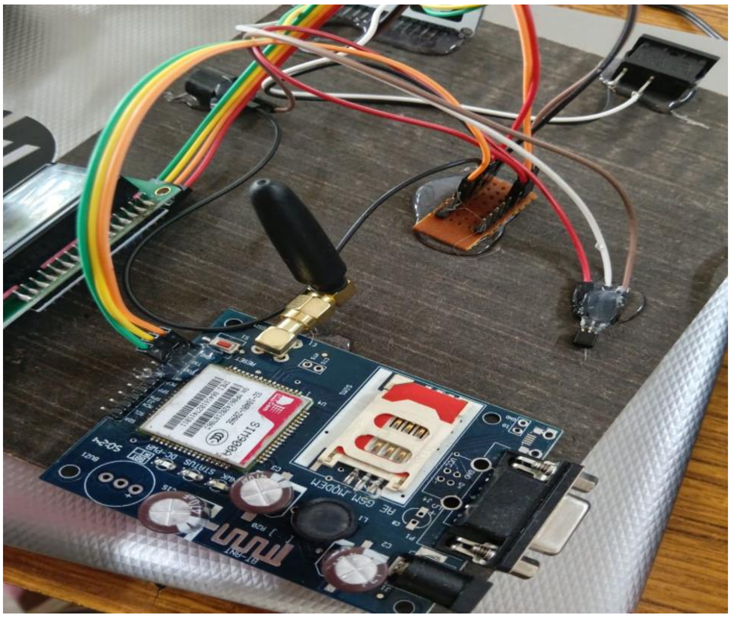


5.2 System Behavior in Real-Time Scenarios

In real-world testing scenarios, the emergency button responded instantly when pressed. The ESP8266 detected the change in digital input and activated the predefined alert sequence. The GPS module then acquired the device's current coordinates and passed them to the controller, which formatted the data into a Google Maps-compatible URL. This message was then transmitted through the GSM module to a pre-configured emergency contact.

The buzzer served as a tactile feedback mechanism to alert the user that the message had been sent. The system returned to idle after completing the alert cycle. In all test cases conducted in open spaces, the message was received by the emergency contact within 3 to 5 seconds of pressing the button. This proves the system’s capability for low-latency real-time alerting, which is critical in emergency situations.

When tested indoors or under obstructed sky view (e.g., buildings, concrete roofs), the GPS sometimes took up to 10–15 seconds to get a lock or, in rare cases, failed to connect. This behavior was expected due to the nature of GPS modules, which require line-of-sight to satellites. Despite these minor delays, the system either retried or transmitted the last known coordinates if available.



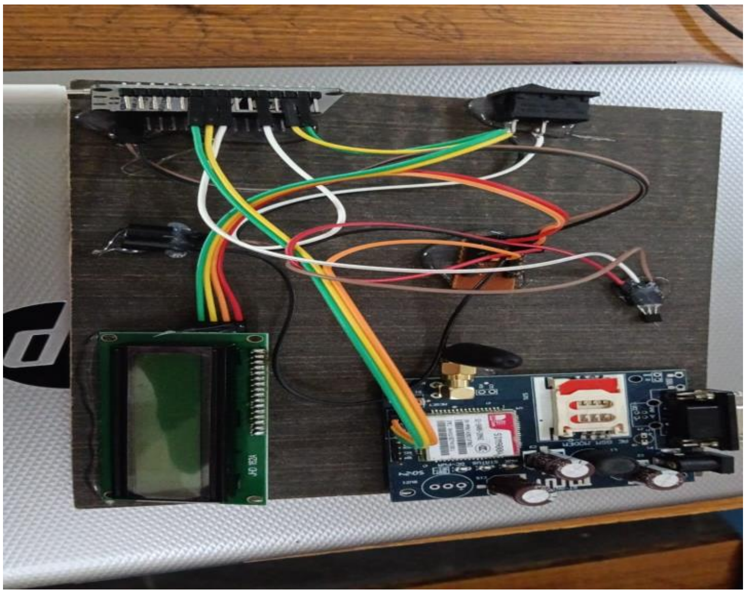
5.5 Discussion on Performance and Accuracy

The device demonstrated excellent performance in terms of component integration, alert reliability, and response time. The use of ESP8266, known for its power efficiency and integrated Wi-Fi, ensured that the system could optionally connect to IoT platforms like Blynk for cloud-based logging. Although the main goal was to operate offline using GSM, the inclusion of Blynk extended the system's potential into smart IoT integration.

One of the most impressive aspects was the SMS-based alert mechanism. It functioned independently of any internet connectivity, making the system viable in rural, forested, or poorly connected regions. The GSM module successfully transmitted emergency messages to multiple carriers (tested on Jio and Airtel networks), showing compatibility and robustness.

Moreover, the LCD and buzzer combination served as effective user feedback tools. Many safety systems fail to provide assurance to users after triggering an alert, which can lead to panic or multiple retries. This system, however, avoided that issue by providing instant confirmation, thereby improving the user experience.

From an energy standpoint, the system consumed low power and could easily run on a 3.7V Li-ion battery for 8–10 hours in standby mode, and slightly less with frequent alerting. This aligns with the portability goal and supports deployment in wearable form factors.

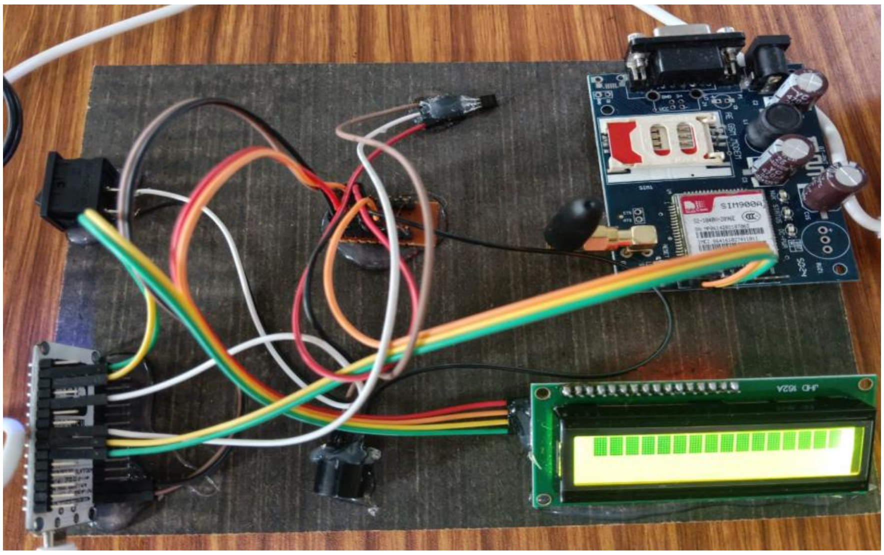


5.4 Challenges Faced and Limitations

Despite successful implementation, a few limitations were identified during the testing and result analysis phase. GPS signal strength was inconsistent indoors, occasionally delaying the transmission of real-time coordinates. While this is a known limitation of GPS technology in general, it suggests the future inclusion of location caching or Wi-Fi triangulation in hybrid systems for faster fixes.

The current prototype, though functionally complete, is not optimized for compactness. The wiring could be condensed using a custom PCB, and the system could be enclosed in a wearable casing such as a wristband, pendant, or clip-on. Moreover, the device currently lacks two-way communication, meaning it cannot receive acknowledgments from the recipient or allow the user to cancel false alerts once triggered.

Additionally, the system requires a physical SIM card and GSM signal to function. In very remote or shielded areas, where GSM networks are unavailable, the SMS alert function would fail. A future enhancement could involve integrating a LoRa-based or satellite-based fallback for such conditions.



In conclusion, the project achieved its intended goals. The emergency button system responded quickly, transmitted GPS-based SMS alerts with accuracy, and provided user feedback—all without requiring internet or smartphones. It is simple to use, energy-efficient, and highly scalable for broader implementation.

The prototype serves as a proof of concept for a real-world IoT safety solution, particularly for vulnerable groups such as women, children, and the elderly. With minor modifications and production-level design, it can evolve into a market-ready product.

VI. CONCLUSION

The project titled “IoT Powered Emergency Button for Women Safety” was successfully designed, implemented, and tested with the primary goal of improving personal security for women in high-risk situations. The system offers a practical and reliable solution that functions independently of smartphones, ensuring that alerts can be sent even when the victim is unable to access a mobile device or when there is no internet connectivity.

This project uses an ESP8266/ESP32 microcontroller as the core processor, interfacing with a GPS module (NEO-6M) for real-time location tracking and a GSM module (SIM800L) for sending SMS-based emergency alerts. A simple push-button mechanism triggers the system, making it intuitive and easy to use under stressful conditions. The inclusion of a buzzer or LED indicator gives the user confirmation that the alert has been successfully sent, thus enhancing user confidence and system reliability.

Furthermore, the integration of Blynk IoT cloud functionality demonstrates how real-time events can be logged and visualized, opening the possibility for future mobile or web-based dashboards accessible to family members or emergency responders.

The final prototype was tested under various real-life conditions, including poor GPS signal environments and GSM signal fluctuations. The system proved to be responsive, accurate in sending alerts, and capable of operating for several hours on battery power. Additionally, the simplicity and affordability of the system make it viable for mass production and deployment across schools, colleges, public transportation, and even remote villages.

Thus, this project addresses a critical gap in real-time emergency alert systems by offering a low-cost, wearable, and network-independent safety device for women.

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