

Smart Women Safety Wearable: IoT-Based Emergency Alert System with One-Touch SOS and Real-Time Location Tracking

Prof.Mriganka Das
School of Engineering
Dayananda Sagar University
Bengaluru, India

Shranga Hegde
School of Engineering
Dayananda Sagar University
Bengaluru, India

Samala Chaithanya
School of Engineering
Dayananda Sagar
University Bengaluru,
India

Pravallika K
School of Engineering
Dayananda Sagar University
Bengaluru, India

Rakshita
School of Engineering
Dayananda Sagar University
Bengaluru, India

Abstract—Personal safety devices should be most effective when their response time is minimized, dependency on complicated interaction with the mobile phone is eliminated, and they are capable of instantaneously locating themselves and sending out an alarm. This paper proposes a practical wearable device for women's safety that relies on an emergency trigger switch, real-time location sensing, and GSM messaging for sending out alerts to pre-designated recipients. The proposed system employs an ESP32 controller, a SIM800L communication interface, a NEO-6M GPS sensor, a single emergency switch, and provides audio or tactile feedback locally. Once the emergency switch is activated, the wearable determines the user's location, generates a Google Map link, and sends an alert message via SMS to pre-configured contacts through the GSM network. The design is deliberately designed to be independent of any phone to avoid the necessity of unlocking and operating a mobile device during an emergency. Apart from the communication sequence, the hardware architecture, controller programming, and fallback mechanism when no GPS signal is available are detailed in this paper.

Index Terms—women safety, wearable device, ESP32, SIM800L, GPS tracking, SOS alert, IoT

I. INTRODUCTION

Personal safety devices are often measured according to how fast they can be engaged in moments of extreme stress. In many cases, there will not be sufficient time for the person being threatened to access his/her smartphone, navigate the app, activate data services, and manually send the location information. This is the core limitation of many personal safety devices on the market today. For a personal safety device to work effectively, it must

reduces the users' interaction effort to merely a single physical operation, taking care of the rest through automated processing.

The objective of this paper is to fulfill the need in practical terms by presenting an IoT-based safety wearable with one-button SOS triggering and real-time locational tracking capabilities. The logic of this concept is straightforward: upon the activation of the button, the system must gather the user's location information, generate an emergency message, and notify selected individuals in real time. The standalone solution would be better compared to the phone-centered solution, as the former reduces response time and eliminates the necessity of using the interface in panic mode.

The proposed solution is based on the ESP32 microcontroller capable of convenient serial communication and low-power control capabilities [3]. GPS-based positioning is performed by the NEO-6M module [5], and alert messaging – by the SIM800L GSM module using an AT-command based messaging stack [4]. Current state-of-the-art wearable safety devices suggest that GPS and GSM technologies can still offer a reasonable combination of features for a distress-alert wearable, enabling location sharing and emergency communication without the constant connection to the Internet [1], [6]. The key contributions of this paper include:

The main contributions of this paper are:

- 1) a practical independent safety wearable structure with a single-tap button activation,
- 2) a circuit-based hardware structure with ESP32, SIM800L, NEO-6M, and battery subsystem,

- 3) a user-centric emergency sequence with contingency measures in case of low GPS lock strength, and
- 4) a prototype-centric design without any fictitious experimental results.

II. RELATED WORK

Women safety gadgets have been designed in several ways, among which are smartphone integrated safety gadgets, GPS-GSM trackers, cloud-assisted safety bands, and smart wearables packed with sensors. In a very recent ScienceDirect report about IoT based women safety gadgets, an essential recommendation for designing such products was the need for distress reporting through an instant trigger mechanism without having prolonged interaction [1]. Similarly, Fem-meBand was designed based on the concept of a smart security band, highlighting the importance of wearable-triggered location sharing in emergencies [2].

In many reported designs, both GPS and GSM technologies were employed, where the former was used for real-time location determination while the latter served the purpose of establishing contact with pre-selected people. The attractiveness of this combination lies in its ability to allow direct contact to be established without the involvement of any phone application and also being applicable in building cheap hardware. This was also the case for previously designed smart band gadgets [6]. Most existing systems are either overly reliant on smart-phones, overly general, or not elaborated enough..

In contrast to that, the idea in question is based on the compactness, self-sufficiency, and circuitry design. By omitting all unnecessary features, such as the sensors not needed for the functionality itself, but for giving an illusion of advanced product development, the suggested invention will focus merely on three aspects: instant activation, localization, and communication during emergencies.

III. PROBLEM STATEMENT

Safety applications for women are generally mobile phone applications; however, this solution will not necessarily be helpful during times when one needs it the most. For example, the phone itself may be out of reach, locked, depleted of battery power, or simply running slowly enough that it would be too difficult to use at the right time.

This problem statement is not simply about “what is an efficient way to deliver an alert?,” but how can we design a product that delivers an alert quickly and easily, along with real-time location data in the form of an independent wearable device. The proposed system should have the following characteristics: support one-touch SOS activation,

- one-button alert triggering,
- position determination using a small GPS module,
- communication capability through the GSM protocol,
- feedback to the user after trigger is activated,

IV. PROPOSED SYSTEM ARCHITECTURE

The designed wearable is composed of four units namely, trigger, processing, positioning, and communication. Trigger comprises a push-button SOS switch. Processing unit is made up of ESP32. Positioning uses NEO-6M GPS module to determine latitudes and longitudes. Communication makes use of SIM800L GSM module to send messages and make phone calls.

As illustrated in Figure 1 below, when the SOS switch event occurs, the microcontroller triggers the request of location using the GPS module. Once the coordinates are acquired, ESP32 creates an emergency message containing a link of Google Maps and sends commands to SIM800L to deliver the message. In addition, the logic could be further applied to place a call to the designated primary number after sending the emergency message..

V. HARDWARE COMPONENTS AND CIRCUIT DESIGN

The choice of hardware is deliberately practical. The ESP32 works as the main controller because it offers flexible routing of UART interfaces and embedded firmware to be used in compact IoT systems [3]. The SIM800L module was chosen since it facilitates GSM connectivity and supports reliable AT command-based control of SMS and voice functionalities [4]. The NEO-6M GPS module was picked up because of its extensive use in embedded GPS projects along with its small size [5].

A. Power Design

Power management design is one of the most significant practical considerations within the system. The power is derived from a Li-ion cell battery and the charger employed is similar to a TP4056 design charger for rechargeable power sources. It is assumed that there will be two different paths through which the power conditioning will be done; one for the logic circuitry and another for the GSM part of the circuit

B. Controller and Peripheral Interface

SOS button monitoring on ESP32, NMEA data collection from GPS by UART, and GSM communication between ESP32 and SIM800L via UART communication channels have been considered. In addition, for providing local feedback, a status LED and a buzzer or a vibrator motor have been added. Note that if a vibration motor is employed for the buzzer, direct connection to the ESP32 GPIO pin must be avoided, and the buzzer is to be implemented through a transistor-driven circuit.

Block diagram of Fig. 2 is oriented to the circuit structure. The power source and the charger provide two circuits: one for the regulated logic level for the ESP32 and the GPS, and another for the communication power source for SIM800L.

C. Suggested Functional Pin Mapping

A prototype design could make use of the pin mapping provided in Table I. The specific pin connections may vary during actual implementation, although the logical groupings must stay the same.

Overall Wearable System Architecture

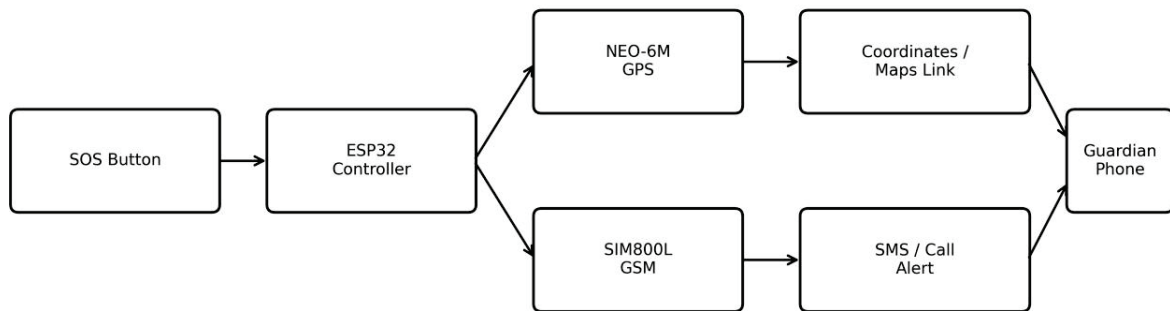


Figure 1: Overall architecture of the wearable system. An SOS button trigger sets off the control, location, and communication sequences.

Circuit-Oriented Block Diagram

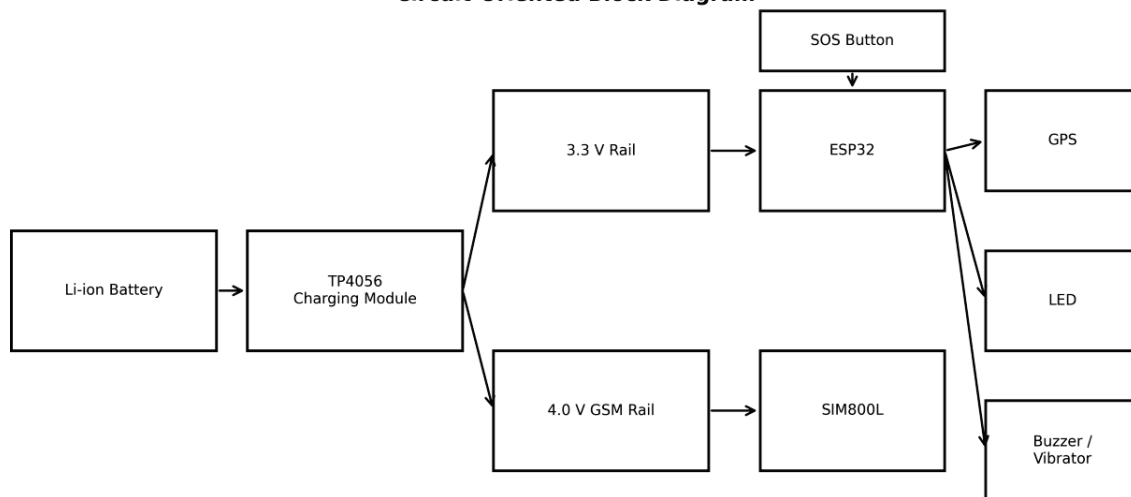


Fig. 2: Block Diagram from Circuit Perspective for Proposed Wearable Device. Supply management has been maintained independently for logic and GSM communication purposes.

V.WORKING METHODOLOGY

The device will be functioning in monitoring mode until the SOS button is pushed. After which, the controller switches to emergency mode and executes the subsequent steps:

- 1) detection of SOS button push,
- 2) local alert,
- 3) GPS location detection or retrieval,
- 4) preparation of emergency message,
- 5) notification via SMS to pre-programmed contacts,
- 6) optional call to primary contact,

return to the monitoring state after completion..

Fig. 3 depicts the logic flow. The process is purposely straightforward since each additional step would add to the delay in reaction. The key aspect here is the fact that no further action is required on behalf of the user after triggering the SOS function

VI.EMERGENCY COMMUNICATION LOGIC

The Communication phase revolves around GSM-based SMS transmission. Upon receiving the latitude and longitude, ESP32 constructs the following text message:

TABLE I: Suggested functional pin mapping

Module	Signal	Suggested Purpose
ESP32	GPIO4	SOS button input
ESP32	GPIO23	Status LED output
ESP32	GPIO18	Buzzer / vibration control
ESP32	UART RX	GPS TX input
ESP32	UART TX	GPS RX or optional config
ESP32	UART TX/RX	SIM800L AT command link
SIM800L	TX/RX	GSM communication path
NEO-6M	TX/RX	Coordinate data output

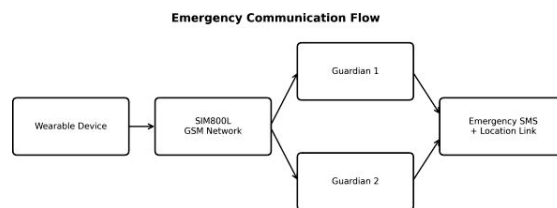


Fig. 4: Process of emergency communication from the wearable device to the designated recipients

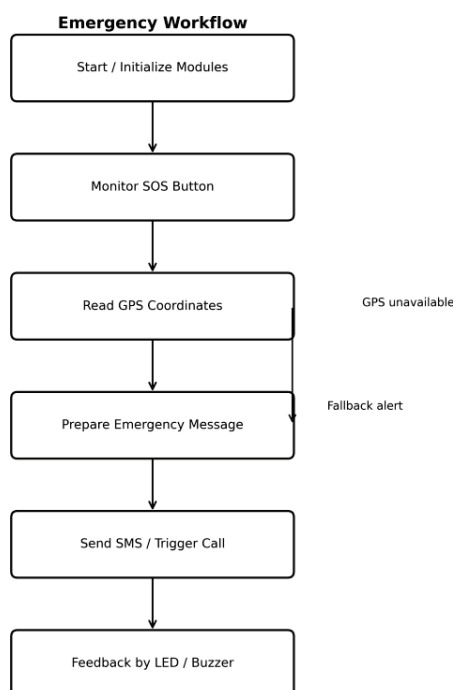


Fig. 3: Workflow for Emergency Case for One Touch SOS Action.

Emergency Alert: I need help. My current location is:
<https://maps.google.com/?q=12.9716,77.5946>

The benefit of using such message structure is that it is very brief and easy to read and action. Moreover, the same mechanism can be used for a series of stored numbers. It is even possible to make an initial call after transmitting the message.

In case there is no valid GPS signal during the limited time window, it will still transmit the message saying that the alerting mechanism had been triggered, even though location information is not known yet. In fact, it is better to receive a delayed alert than an incomplete one.

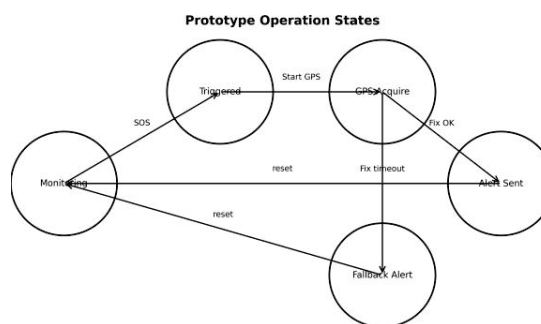


Figure 5: Prototype states during monitoring, alarm triggering, and fallback.

VII.PROTOTYPE OPERATION STATES

The controller uses a simple state machine design shown in Fig. 5 below. Initially, it starts in the monitor state and then proceeds to the trigger state and tries to connect with the GPS service. Upon successful positioning, it triggers either an alert or a backup alert.

The use of state-based design makes it easier to implement and debug. Moreover, there is provision for future extension based on functionality such as cancellation of alarms, re-transmission of alerts, and low battery alerts.

VIII.PRACTICAL DISCUSSION

This proposed device purposely keeps things simple. It's one of the strong points about this system. Many scholarly safety-device articles include cloud dashboards, biometric sensing systems, camera components, or machine learning systems without verifying that the primary emergency communication route works well first. But in this case, the goal is utility first:

- A single button press for emergency support,
- No need to unlock your phone,
- Location transmitted directly by SMS,
- Confirmation that your message was sent.

With regards to wearables, power, size of the modules, and GSM/GPS functionality are the most challenging factors. GPS functionality

GPS location may fail to operate in indoor conditions or under heavy obstructions, whereas reliability for GSM depends on network coverage. It is an actual implementation issue and not a design weakness that must be pointed out..

IX.LIMITATIONS AND FUTURE WORK

The current design is one of a prototype and hence has its limitations. Firstly, GPS location cannot always be available instantly in indoor or shielded conditions. Secondly, the SIM800L communication channel depends on GSM network coverage. Lastly, while the overall block design allows for wearability, ultimate miniaturization needs PCB design, casing design, and battery considerations.

- Future work may include incorporating the following features:
- Automated retries for alerts,
- Mobile application logs as supplementary but not sole functionality,
- An inertial measurement unit for struggle detection,
- Low battery warnings via transmission, and encrypted contact and configuration storage.

X.CONCLUSION

This work discussed the implementation of a practical smart women safety wearable using a one touch SOS switch,

GSM emergency communication protocol, and GPS reporting for real-time location sharing. The proposed solution uses ESP32 as a controller with the help of a SIM800L communication device and NEO-6M GPS module to provide an alternative communication path to avoid smartphone navigation through panic situations. Moreover, the proposed design was discussed along with message flow and fallback mechanisms in case of unavailability of GPS information. It can be observed that the proposed design takes a practical perspective in the domain of embedded system design and avoids unrealistic promises.

REFERENCES

- [1] S. Saxena and others, "IoT-based women safety gadgets (WSG)," *Journal of Systems and Software*, 2023.
- [2] P. Rani and others, "FemmeBand: a novel IoT application of smart security band for women," *International Journal of System Assurance Engineering and Management*, 2022.
- [3] Espressif Systems, "ESP32 series datasheet," 2025.
- [4] SIMCom, "SIM800 series product page and hardware design documents," 2026.
- [5] u-blox, "NEO-6 GPS modules data sheet," 2011.
- [6] B. Sathyasri and others, "Design and implementation of women safety system based on IoT technology," 2019.