OnePress SOS: A Smart IoT Framework for Women's Safety

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***Abstract*—Women's safety is a critical issue in Bangladesh, where existing solutions such as helplines and mobile apps often fail during emergencies due to complex activation or network dependence. This paper presents OnePress SOS, a compact IoT-based wearable safety device designed for discreet and rapid response. The system integrates ESP32-CAM, Arduino Nano, GSM, and GPS modules, all activated by a single switch to minimize effort under stress. Once triggered, the device captures real-time images and transmits them via a Telegram bot, sends SMS alerts with GPS coordinates and Google Maps links, and activates a buzzer to deter attackers. Additional features include a pulse oximeter for vital sign monitoring and Raspberry Pi with IR sensing for contextual awareness. Experimental results confirm reliable image capture, accurate location tracking, and consistent alert delivery. While limitations include reliance on network availability and manual activation, the prototype offers a practical, low-cost framework. Future enhancements will focus on automated distress detection, extended battery life, and two-way communication for greater resilience.**

***Index Terms*—component, formatting, style, styling, insert**

I. Introduction

Women's safety is a pressing concern in Bangladesh, where harassment, assault, and intimate partner violence remain alarmingly widespread. A significant proportion of women continue to face abuse, both physical and psychological, highlighting the urgent need for rapid, reliable, and discreet protection mechanisms. While existing solutions such as helplines, safety apps, and IoT-based devices are available, they often prove ineffective in real emergencies due to their reliance on smartphones, continuous monitoring, or complex activation processes. To address these challenges, we propose a compact IoT-based wearable device that integrates an ESP32-CAM, Arduino Nano, and GSM/GPS modules into a unified framework. The system is activated through a single switch, minimizing effort during high-stress situations. Once triggered, it captures and transmits real-time images via a Telegram bot, sends SMS alerts with GPS location, and activates a buzzer for immediate deterrence. In addition, a Raspberry Pi 3 is connected with an IR sensor that detects ambient light to determine whether it is day or night. Based on this detection, it displays a corresponding image and allows users to access the information remotely by logging into the Raspberry Pi's official website. By combining visual evidence, dual communication pathways, intelligent sensing, and a discreet wearable design, the device ensures fast, reliable, and user-friendly emergency response, offering practical protection where conventional solutions often fail.

II. Literature Review

Women's safety in both public and private spaces continues to be a pressing social challenge, with technology-based solutions emerging as a promising line of defense. In recent years, researchers have proposed various IoT-enabled wearable and portable devices aimed at providing emergency alerts, location tracking, and self-defense mechanisms.

Wasim Akram et al. (2019) [1] designed a smart IoT-based safety device that overcomes the limitations of handheld gadgets requiring manual activation. Their device integrates a fingerprint-based connectivity system that automatically triggers alerts if verification fails, and it incorporates a shockwave generator for self-defense. However, the dependency on fingerprint verification may delay response in high-stress scenarios, and the design lacks multi-layered data sharing beyond messaging.

Mohamad Zikriya et al. (2018) [2] introduced a wearable "Smart Gadget" that communicates continuously with a smartphone. It can capture an image of a perpetrator and send it with the victim's location, while also offering electric shock gloves and a pendant with LED flash for disorienting attackers. Although innovative, the device depends heavily on smartphone connectivity and internet-based APIs (e.g., Twilio), which may limit usability in areas with poor network coverage.

Dr. C. K. Gomathy et al. (2022) [3] proposed a compact, ultra-low power wearable device based on Arduino, featuring a panic switch to activate a buzzer, laser diode, and shock mechanism while transmitting GPS-based alerts through GSM. While energy-efficient and portable, the system relies mainly on manual activation, lacking automated context-sensitive triggers or evidence capture.

D. G. Monisha et al. (2016) [4] developed FEMME, a combined hardware–software solution with an Android application, Bluetooth synchronization, and multifunctional emergency modes such as single click (GPS + message), double click (audio recording), and long press (call to police). Notably, the device integrates a hidden camera detector, enhancing privacy protection. Nevertheless, the reliance on Bluetooth connectivity restricts the device's autonomy and range of operation.

Beyond these foundational works, several other IoT-based safety solutions have been proposed. Gautam et al. [5] presented a wearable device using ESP32, but primarily focused on fitness-band style applications rather than multi-modal emergency response. Satpute et al. [6] designed a smart safety device featuring fingerprint activation, GSM-based messaging, and shockwave defense, yet with limited integration of evidence capture. Tejonidhi et al. [7] introduced a smart band integrating GSM and GPS, but the design remained dependent on Raspberry Pi, which constrains portability. Similarly, Saxena et al. [8] outlined an IoT-based Women Safety Gadget (WSG) with multi-layered architecture and rapid response time, but requiring complex cloud infrastructure and pepper spray deployment, which raises portability and safety concerns. Ali et al. [9] developed IoT-based smart gloves with GSM and GPS modules, but the glove form factor limits discretion and everyday usability. Uvaana Falicica et al. [10] proposed an IoT-based wristband connected via Blynk app, though dependent on continuous internet access. Raja and Viswanath proposed smart foot devices that can discreetly trigger emergency alerts through specific foot gestures, but these solutions are limited in functionality, lacking integrated communication and evidence collection features. Finally, Raian et al. [11] designed jewelry-like safety devices (BOHNNI and BADHON), integrating voice recognition and shock defense, achieving high accuracy but prioritizing aesthetic appeal over technical scalability.

Across this body of work, common trends include reliance on GSM and GPS for location sharing, the integration of self-defense mechanisms such as electric shocks or pepper spray, and smartphone-based communication channels. However, several limitations persist: heavy dependence on continuous internet connectivity, lack of simultaneous evidence capture such as real-time images, limited portability due to bulky hardware, and insufficient discreetness for daily wear.

The proposed prototype in this paper addresses these gaps by introducing a wearable, locket-style device integrating ESP32-CAM, Arduino Nano, GSM, and GPS. Unlike prior works, it enables real-time transmission of images through a Telegram bot, ensuring immediate sharing of visual proof with trusted contacts, while also being compact and discreet enough for everyday use. By combining portability with visual evidence and geolocation alerts, the system advances the state of women's safety devices beyond the scope of earlier designs. The wearable safety device shows good performance and provides a strong multi-layered emergency response system, but it also has several important limitations that need to be addressed. First, the device depends on mobile networks for sending SMS alerts and on internet connectivity for sending Telegram notifications. This means that in areas with weak or no network coverage, the alert system may be delayed or even fail to deliver messages for a certain time, which could reduce its effectiveness during emergencies.

Another limitation is that the device currently requires manual activation through a tactile push-button. While this makes the system simple to use, it also creates a problem if the user is unconscious, injured, or unable to press the button. In such situations, the device may not be able to trigger alerts at the most critical moment.

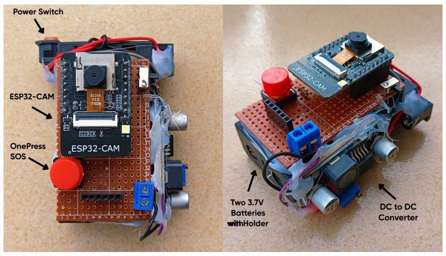
In terms of location tracking, the built-in GPS module generally provides meter-level accuracy. However, its performance can drop in certain conditions such as when the user is indoors, in crowded urban environments, or in areas with tall buildings and physical obstructions. This can result in less precise location sharing, making it harder for emergency contacts to locate the person in need.

The system also lacks physiological monitoring or automatic distress detection features. Adding such capabilities, like monitoring heart rate, sudden movement, or unusual inactivity, could make the device more advanced and responsive by automatically triggering alerts without manual input.

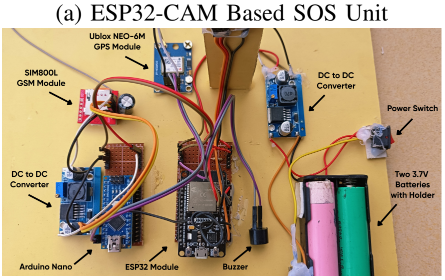
Battery life and the compact size of the wearable limit how long it can continuously operate. Frequent recharging may be required, which could be inconvenient during long outdoor use. Furthermore, the device only supports one-way communication, meaning it can send alerts but does not allow real-time interaction with emergency contacts. This prevents direct feedback, reassurance, or further instructions during emergencies.

These limitations highlight clear opportunities for improvement. Future versions of the device could benefit from stronger and more versatile connectivity, automated distress detection, improved GPS accuracy, extended battery life, and two-way communication features. By addressing these issues, the wearable safety device could become a more reliable, autonomous, and effective tool for ensuring user safety in all environments.

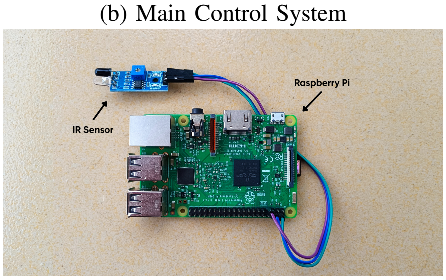
III. Proposed Design



(a) ESP32-CAM Based SOS Unit



(b) Main Control System



(c) Raspberry Pi with IR Sensor

Fig. 1: Hardware setup of the proposed emergency monitoring and alert system.

The proposed wearable safety device is conceptualized as a compact, discreet, and portable system that integrates multiple IoT-based modules to ensure rapid emergency response with minimal user effort. The architecture of the system revolves around four primary components: the ESP32-CAM, Arduino Nano, GSM module, and GPS module, which work together in a synchronized sequence to deliver layered protection.

From Figure 1a, the heart of the system, ESP32-CAM, functions as both the visual evidence collector and the communication hub. When triggered, it immediately activates its onboard camera to capture a real-time image of the surroundings. This image is transmitted securely to a pre-configured Telegram channel, providing trusted contacts with instant visual confirmation of the user's situation. Unlike systems that rely solely on GPS or SMS, the inclusion of image data enhances the credibility and clarity of the alert, allowing emergency responders or family members to better assess the severity of the incident.

The proposed wearable safety device is developed using a combination of hardware and software components that work together to deliver a reliable multi-layered emergency response system. The main components are:

- ESP32-CAM: Serves as the central processing unit, capturing real-time images and transmitting them via Wi-Fi to a Telegram bot for instant sharing with trusted contacts.
- Arduino Nano: Acts as a secondary microcontroller, managing the GSM and GPS modules and ensuring proper coordination of location acquisition and SMS transmission.
- GSM Module (SIM800L/SIM900A): Enables cellular communication by sending SMS alerts to predefined emergency contacts. These messages include raw latitude–longitude coordinates and a clickable Google Maps link.
- GPS Module (NEO-6M): Provides real-time location tracking with meter-level accuracy, ensuring precise victim positioning in emergencies.
- Buzzer: Generates an audible alert when triggered, acting both as a deterrent to attackers and as confirmation for the user.
- Switch: A single tactile button activates the device, minimizing the user's effort in high-stress situations.
- Power Supply: A rechargeable battery powers the device, allowing portability and integration into wearable formats such as a pendant or locket.
- Pulse Oximeter: Monitors vital signs such as heart rate and blood oxygen levels, offering real-time health monitoring that can complement the emergency alert system.
- Raspberry Pi with IR Connection: Works as an auxiliary processing and monitoring unit, handling data from IR sensors (such as motion or health-related sensors) and enabling additional safety functionalities.

Upon activation, the Arduino Nano coordinates the GSM and GPS modules. The GPS module retrieves latitude and longitude data, while the GSM module formats it into a structured SOS message containing both raw coordinates and a Google Maps link. This redundancy ensures reliable communication even when internet connectivity is weak or unavailable.

The activation mechanism is intentionally simple: a single push-button switch. With one press, all safety functions—image capture, Telegram communication, SMS location sharing, buzzer activation, and optional health monitoring—are triggered simultaneously. The buzzer provides immediate audible feedback, deterring aggressors and assuring the user that the system is active.

In addition, the integration of a pulse oximeter and Raspberry Pi with IR connection expands the system's capabilities beyond emergency alerts. The pulse oximeter continuously tracks vital signs, which can be shared with medical responders if needed, while the Raspberry Pi processes IR-based data for auxiliary safety and health monitoring.

The device is designed with portability and discretion in mind, allowing it to be worn as a locket, pendant, or clipped to clothing. Its compact and lightweight structure ensures everyday usability without attracting undue attention. An overview of the proposed hardware design is shown in Figure 1.

IV. Experimental Setup

The experimental setup for the proposed IoT-based women's safety device was developed and tested entirely in the Arduino IDE using three separate sketches written in standard Arduino C/C++. The image-capture sketch, compiled and uploaded to the ESP32-CAM, captures a JPEG image as soon as the emergency switch is pressed and forwards it to the main ESP32 controller. The alert-handling sketch, running on the ESP32, activates the buzzer for local feedback, communicates with the Telegram bot to upload the captured image, and simultaneously sends a digital high signal to the Arduino Nano to initiate the SMS procedure. The location-tracking sketch, running on the Arduino Nano, reads real-time GPS coordinates from the Ublox NEO-6M GPS module and uses the SIM800L GSM module to send an SOS text message containing a Google Maps link to predefined emergency contacts. Once powered, pressing the switch triggers the full workflow automatically: image capture and upload, buzzer activation, and location sharing via SMS, thereby completing the end-to-end emergency alert process.

V. Working Procedure

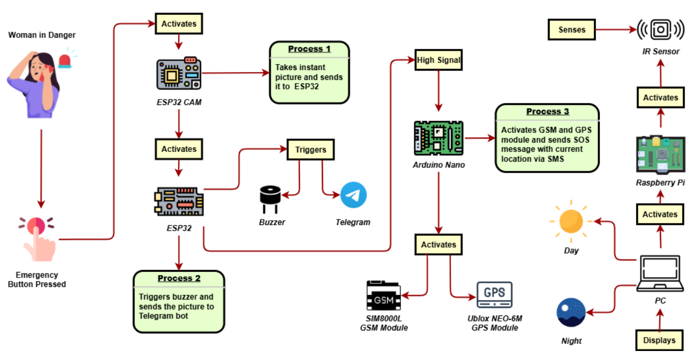


Fig. 2: Working Procedure

If a woman finds herself in danger, she can activate the device simply by pressing the SOS button. This single action immediately triggers the buzzer, producing a loud sound to alert people nearby and deter the attacker. At the same time, the signal is sent to the ESP32-CAM module, which instantly captures real-time images of the surrounding environment. These images are processed and stored under the ESP32's IP address for remote access, while copies are also transmitted directly to a pre-configured Telegram channel. This ensures that trusted contacts receive immediate visual evidence of the situation without requiring any manual interaction from the victim.

Simultaneously, the ESP32 sends a high signal to the Arduino Nano to initiate the next stage of the emergency protocol. The Arduino Nano activates the GSM and GPS modules. Through the GSM module, an SOS message is automatically sent to predefined emergency contacts. Along with this message, the GPS module provides precise latitude and longitude coordinates in the form of a clickable Google Maps link. This allows rescuers or family members to instantly locate the victim and respond without delay.

In addition to image and location sharing, the device also provides contextual and health information to strengthen situational awareness. A Raspberry Pi 3 connected to an IR sensor detects the ambient light level and determines whether it is day or night, making this information available through a web interface hosted on the Raspberry Pi. At the same time, an oximeter and pulse detector linked to the ESP32 continuously monitor the victim's vital signs, such as heart rate and oxygen level, which can be viewed remotely on a mobile phone. These health readings can play a crucial role in assessing the victim's physical state during the emergency.

All modules are powered through regulated 3.7V lithium-ion batteries, ensuring reliable operation in critical moments. With its discreet design, compact hardware, and single-button activation, the system minimizes the effort required by the victim and ensures that help is notified as quickly as possible.

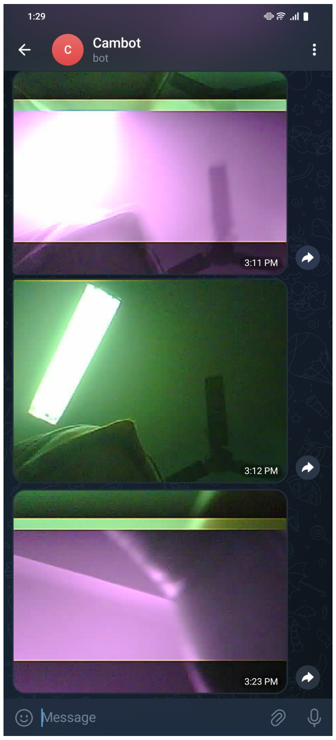
Through this workflow, the proposed system combines visual proof, real-time geolocation, health monitoring, and dual communication pathways (Telegram and SMS), making it a practical, low-cost, and highly reliable safety solution for women under threat.

VI. Result Analysis

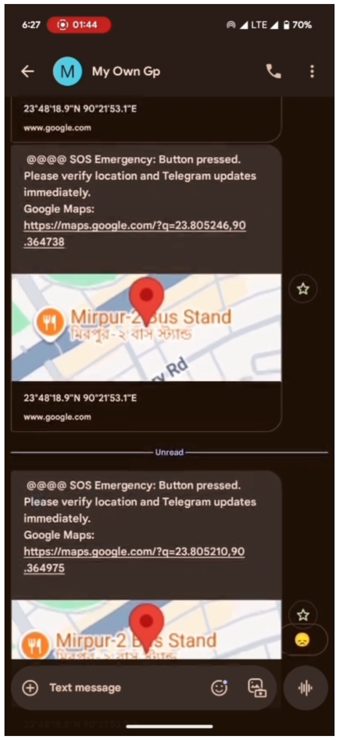
The proposed wearable safety device was systematically tested to validate its performance and reliability in real-world scenarios. Initially, the ESP32-CAM module was configured and tested to ensure proper setup and network connectivity. Once confirmed, the device was activated using the tactile push-button switch, which immediately triggered the camera module. As illustrated in Figure 3a, the ESP32-CAM captures real-time images of the surrounding environment and transmits them to a pre-configured Telegram bot. This enables instant visual evidence sharing with trusted contacts, providing immediate situational awareness in emergency situations.

Simultaneously, the GSM and GPS modules were evaluated to verify accurate positioning and timely communication. Upon activation, the GPS module acquires precise latitude and longitude coordinates of the user. The Arduino Nano coordinates this information with the GSM module, which formats and sends SMS alerts to predefined emergency contacts. As demonstrated in Figure 3b, the SMS contains both raw coordinates and a clickable Google Maps link, allowing recipients to quickly and accurately locate the user regardless of their technical proficiency.

Further validation was performed using real-time navigation in Google Maps. The live GPS output, shown in Figure 3c,

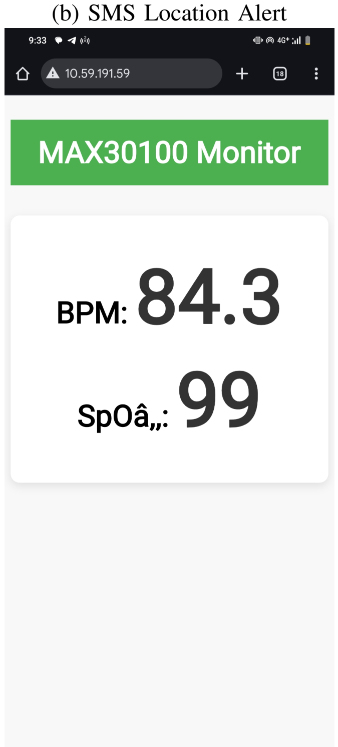


(a) ESP32-CAM Output



(b) SMS Location Alert

(c) GPS Navigation Output



(d) Oximeter Reading

Fig. 3: Result Analysis

confirmed meter-level accuracy, ensuring that the user's position could be reliably tracked in both indoor and outdoor environments. This demonstrates the device's capability to support emergency responders or family members in locating the victim promptly.

In addition to these modules, the integrated oximeter sensor was tested to assess the user's physiological condition , shown in Figure 3d . The oximeter provides real-time measurements of blood oxygen saturation (SpO_2) and heart rate. During experiments, the readings were displayed promptly and consistently, offering valuable health indicators that could help identify distress situations such as sudden drops in oxygen level or abnormal heartbeats. By integrating this feature, the device extends its functionality beyond emergency alerts, enabling continuous health monitoring as an additional safety layer.

In addition to digital alerts, the integrated buzzer was tested to provide immediate local feedback. Upon device activation, the buzzer emits a loud audible signal that serves a dual purpose: deterring potential threats and confirming to the user that the emergency sequence has been successfully initiated. This local alert complements the digital communication channels, bridging the gap between online notifications and real-world awareness.

Throughout multiple test scenarios, the device consistently performed as intended. Visual evidence was transmitted without delay, GPS coordinates were accurate and promptly delivered via SMS, oximeter readings were stable and informative, and the buzzer reliably provided local alerts. These results confirm that the system achieves its design goals: it is portable, discreet, and capable of delivering a multi-layered emergency response. The combined functionality of image capture, location tracking, physiological monitoring, SMS communication, and audible alert demonstrates the practical applicability of the proposed IoT-based wearable safety system for women in both urban and rural contexts.

VII. Limitations

The wearable safety device shows good performance and provides a strong multi-layered emergency response system, but it also has several important limitations that need to be addressed. First, the device depends on mobile networks for sending SMS alerts and on internet connectivity for sending Telegram notifications. This means that in areas with weak or no network coverage, the alert system may be delayed or even fail to deliver messages for a certain time, which could reduce its effectiveness during emergencies.

Another limitation is that the device currently requires manual activation through a tactile push-button. While this makes the system simple to use, it also creates a problem if the user is unconscious, injured, or unable to press the button. In such situations, the device may not be able to trigger alerts at the most critical moment.

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The system also lacks physiological monitoring or automatic distress detection features. Adding such capabilities, like monitoring heart rate, sudden movement, or unusual inactivity, could make the device more advanced and responsive by automatically triggering alerts without manual input.

Battery life and the compact size of the wearable limit how long it can continuously operate. Frequent recharging may be required, which could be inconvenient during long outdoor use. Furthermore, the device only supports one-way communication, meaning it can send alerts but does not allow real-time interaction with emergency contacts. This prevents direct feedback, reassurance, or further instructions during emergencies.

These limitations highlight clear opportunities for improvement. Future versions of the device could benefit from stronger and more versatile connectivity, automated distress detection, improved GPS accuracy, extended battery life, and two-way communication features. By addressing these issues, the wearable safety device could become a more reliable, autonomous, and effective tool for ensuring user safety in all environments.

VIII. Conclusion and Future Work

For future improvements, the device can be made smarter and more reliable by adding extra features. One idea is to include health sensors, such as a pulse oximeter, to measure heart rate and oxygen levels. This would allow the device to detect unusual health conditions and send alerts automatically, even if the user cannot press the button. Another improvement could be motion-based or voice-based activation, so the device can respond more quickly and naturally in emergencies.

The system can also be upgraded to send alerts to many contacts at the same time through cloud-based services, ensuring that help reaches faster. Making the device smaller and improving the battery would increase comfort and allow it to be used for longer periods. Adding live video streaming and two-way communication could make it not just a safety tool, but also a full personal security and health monitoring device.

In the long term, the device could use AI for detecting threats, have more secure data transmission, and use energy-efficient designs. These upgrades would make the system more advanced, proactive, and dependable in real-life situations.

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