

## Design and Implementation of a Smart Safety Bag for Women's Protection: A Comprehensive Study

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### ABSTRACT:

Ensuring women's safety remains a critical societal concern, prompting the development of innovative safety devices tailored to their needs. This abstract explores various technological advancements aimed at enhancing women's safety in diverse settings. From compact personal alarms to discreet wearable gadgets equipped with GPS tracking, these devices provide immediate alerts and location data in distress situations. Moreover, smart applications integrate emergency contact notifications and real-time monitoring features, fostering a network of support for users. The evolution of such devices reflects a proactive approach to addressing safety concerns, empowering women to navigate public spaces with greater confidence and security. Challenges such as affordability, accessibility, and user acceptance underscore ongoing research and development efforts in this field. As technology continues to advance, the integration of artificial intelligence and machine learning promises further enhancements in predicting and preventing potential threats. Ultimately, the efficacy of these devices hinges on comprehensive user education and community engagement to foster a culture of safety and support for women worldwide.

**Keywords: Global Positioning System (GPS), General Packet Radio service(GPRS), Universal Asynchronous Receiver / Transmitter (UART)**

### 1. INTRODUCTION

Ensuring women's safety remains a critical issue in today's society, shaped by several pressing needs and challenges. Women often face the threat of physical violence, harassment, and assault in various public and private spaces. The need for safe environments, effective law enforcement, and responsive support systems is paramount. Deep-rooted cultural norms and attitudes often perpetuate gender-based violence and discrimination. Addressing these requires widespread education, advocacy, and legislative changes to promote gender equality and respect. Laws must be strengthened and enforced to protect women from violence and ensure perpetrators are held accountable. Access to justice, legal aid, and fair trials are crucial for empowering survivors and preventing impunity. Victims of violence require comprehensive psychological support and counselling services to heal from trauma and rebuild their lives. These services should be accessible, stigma-free, and tailored to individual needs. Education plays a pivotal role in challenging stereotypes, promoting respectful relationships, and fostering gender sensitivity from a young age. Comprehensive sex education can empower girls and boys with knowledge

about consent, boundaries, and healthy relationships. Women's economic empowerment through access to education, employment opportunities, and financial resources is essential for reducing vulnerability to violence and achieving equality in society. Advancements in technology can aid women's safety through apps, emergency response systems, and digital platforms that facilitate reporting, tracking, and preventing incidents of violence. Building strong community networks, support groups, and safe spaces where women can seek solidarity, advice, and assistance can enhance safety and resilience. Advocacy efforts are crucial for influencing policies that prioritize women's safety, allocate resources effectively, and hold institutions accountable for protecting women's rights. Recognizing and addressing the diverse needs and vulnerabilities of women from different backgrounds, including race, ethnicity, socioeconomic status, disability, and sexual orientation, is essential for inclusive and effective safety measures. Overall, ensuring women's safety requires a multifaceted approach that involves legislative reforms, societal shifts in attitudes and norms, comprehensive support systems, and empowering women to assert their rights and live free from fear. Over the past decade, there has been a significant increase in reported cases of attacks and threats against women in India. While specific statistics can vary based on reporting mechanisms and data sources, several trends and factors contribute to this concerning rise. One notable factor contributing to the apparent rise in cases is improved reporting mechanisms and increased awareness among women about their rights and the importance of reporting incidents. This has led to more cases being documented compared to previous years when many incidents went unreported due to social stigma, fear of reprisal, or lack of confidence in the justice system. Legislative changes and public awareness campaigns have also encouraged more women to come forward and report instances of violence, harassment, and threats. Laws such as the Protection of Women from Domestic Violence Act (2005) and amendments to the Indian Penal Code

(IPC) have broadened the definition of crimes against women and strengthened penalties for offenders. Increased media coverage of incidents involving violence against women has also contributed to greater awareness and public discourse on the issue. High-profile cases have sparked widespread outrage and demands for stricter enforcement of laws and improved safety measures. Despite legal reforms and awareness campaigns, deep-seated social norms, patriarchal attitudes, and gender inequalities continue to perpetuate violence against women in various forms. These factors create a challenging environment where women often face barriers to seeking justice and protection. The rise of digital platforms and social media has both facilitated reporting of incidents and, unfortunately, provided new avenues for harassment and threats against women, including cyberbullying, online stalking. Despite legal provisions, challenges persist in effective law enforcement, timely justice delivery, and the implementation of protective measures for women. This can contribute to a perception of increasing vulnerability among women. While quantitative data specifically detailing the increase in cases over the past decade may vary, the qualitative evidence and societal awareness suggest a growing recognition of the pervasive nature of violence against women in India. Addressing this complex issue requires a multifaceted approach involving legislative reforms, comprehensive support systems, cultural shifts, and enhanced enforcement of laws to ensure the safety and dignity of women across the country.[5]

## 2. Analysis of related Works

The analysis of related works on Women Safety Bags highlights a growing intersection of technology and personal safety. Research indicates that these products are designed to address the rising

concerns of women's safety in public spaces. Many innovations incorporate advanced features such as GPS tracking, alarm systems, and smartphone connectivity to alert emergency contacts.

Some studies emphasize the importance of user-friendly interfaces and discreet designs to ensure ease of use and to avoid drawing attention. Other works discuss the integration of self-defence tools like pepper spray or stun guns within the bags.

Evaluations of existing products often focus on the effectiveness, reliability, and practicality of these safety mechanisms, as well as their psychological impact on users' sense of security. Overall, the literature suggests a positive reception of these devices, while also pointing out areas for improvement, such as battery life, cost, and the need for widespread awareness and training on their use [1].

While other women's safety projects focus on mobile apps that require a user to download and configure, or devices that need to be carried separately, our women's safety bag takes a more holistic approach by integrating safety features directly into a bag that women already carry with them daily. Unlike other solutions that may require a power source or internet connectivity, our bag is a self-contained, low-tech solution that provides an added layer of protection without the need for additional devices or subscriptions. Furthermore, our bag's design prioritizes discretion and style, ensuring that women can feel safe without drawing attention to themselves [2]. They go anywhere safely and securely. By combining functionality with fashion, our women's safety bag offers a unique and effective solution for women's safety on-the-go.

Women safety projects often focus on providing tools and technologies to enhance personal security. Common initiatives include mobile apps like "bSafe" and "Circle of 6" which offer features like emergency alerts, GPS tracking, and designated contacts for quick help [3]. These apps enable women to

alert trusted friends or family members if they feel unsafe, providing real-time location data and the ability to send distress signals carefully. In contrast, our Women Safety Bag integrates physical safety mechanisms into everyday carry items, offering an innovative and tangible solution. Unlike mobile apps that require a charged phone and network connectivity, our bag is equipped with built-in safety features such as a high-decibel alarm, GPS tracking, and a hidden camera. The alarm can deter potential threats, while the GPS tracker ensures location monitoring even without a smartphone. Additionally, the hidden camera can capture evidence in real-time, which is crucial for both deterrence and subsequent legal actions. Our bag also offers the practicality of a daily accessory, making it a discreet yet effective safety tool [4]. This contrasts with other projects which often require carrying separate devices or relying heavily on smartphone functionality. The integration of these features into a stylish and functional bag means that it can be seamlessly incorporated into daily routines, providing constant protection without the need for additional steps or devices [5]. Furthermore, our Women Safety Bag addresses the limitations of digital-only solutions, such as battery dependency and network issues, by combining technology with practical design. This hybrid approach ensures that safety is not compromised by external factors like phone battery life or signal strength. Overall, while many women safety projects focus on digital solutions, our Women Safety Bag offers a unique, multi-functional approach that merges practicality with advanced safety features, ensuring continuous and reliable protection in various scenarios [6].

### 3. OUR CONTRIBUTIONS

Our contribution to the Women Safety Bag project has been multifaceted, focusing on both technological innovation and practical usability. We have developed a lightweight,

stylish bag equipped with an array of safety features such as a built-in GPS tracker, an emergency alarm system, and a mobile connectivity module for instant SOS alerts.

The bag includes an easy-access compartment for self-defence tools and integrates with a smartphone app that can notify predefined contacts in case of an emergency. Our design process emphasized user feedback, ensuring that the bag is not only secure but also convenient and fashionable. By combining advanced technology with everyday functionality, we aim to empower women, providing them with an added layer of security and peace of mind in their daily lives.

#### 4. METHODOLOGY OF OUR SOLUTION

The methodology of a women safety bag equipped with GPS tracking, alert messaging via Telegram or SMS to nearby police stations, and a pressure sensor with an alarming buzzer can be outlined as follows. When triggered by the user or automatically via a pressure sensor, the bag sends an alert message containing the GPS coordinates to predefined contacts. A pressure sensor activates when it detects a change in pressure beyond a predetermined threshold. Here's a basic overview of how a pressure sensor works and how it can be used in a safety device like a women's safety bag. When pressure is applied to the sensor (e.g., by squeezing or pressing the safety bag), the sensor's internal mechanism reacts to this force. The sensor then generates an electrical signal proportional to the applied pressure [2]. The pressure sensor is typically calibrated to activate when a certain amount of pressure is exerted on it. This threshold can be set during the design and calibration of the sensor to ensure it triggers reliably under conditions indicative of distress or emergency situations. Upon detecting pressure above the set threshold, the pressure sensor outputs an electrical signal. This signal serves as a trigger which allows a GPS module that continuously tracks its location in real-time. GPS (Global Positioning System) is a satellite-based navigation system that allows devices equipped

with a GPS receiver to determine their precise location anywhere on Earth. The GPS system consists of a constellation of satellites orbiting the Earth. Currently, there are approximately 30 operational GPS satellites maintained by the United States government [3]. Each GPS satellite continuously transmits signals containing precise timing and positioning information. These signals travel at the speed of light and are received by GPS receivers on Earth. To determine its location, a GPS receiver needs to receive signals from multiple satellites simultaneously. Each satellite signal includes, the satellite's position (ephemeris data) and the precise time the signal was transmitted (clock data). When the GPS receiver receives signals from at least four satellites (three for 2D positioning, four for 3D positioning), it uses the timing and position data from each satellite to calculate its own three-dimensional position

(latitude, longitude, and altitude). The GPS module inside a device (such as a Smartphone, GPS tracker, or safety bag) contains a receiver that processes the satellite signals [4]. It uses algorithms to calculate the distance from the receiver to each satellite based on signal travel time (since the signal travels at the speed of light, the distance can be determined from the time delay). Use trilateration to compute the receiver's precise location based on the intersection of spheres (or in three dimensions, spheres or spheroids) centred on each satellite. The accuracy of GPS positioning depends on several factors, including the number of satellites visible, the geometry of their positions relative to the receiver, atmospheric conditions, and the quality of the receiver itself. Modern GPS modules can typically provide location accuracy within a few meters under ideal conditions. GPS modules are integrated into various devices and systems for navigation, mapping, tracking, and location-based services. They often communicate location data to

applications or services that interpret and utilize this information for various purposes, such as providing directions, tracking assets, or sending emergency alerts. In summary, a GPS module works by receiving signals from multiple satellites, calculating distances based on signal timing, and using this information to determine precise geographical coordinates for the device or object it is integrated into. This technology has revolutionized navigation and location-based services across the globe. This can be done through Telegram, SMS, or both, ensuring reliable communication even in areas with limited network coverage by a GSM module. A GSM modem works by utilizing the GSM (Global System for Mobile Communications) network infrastructure to send and receive data, including text messages (SMS). Here's how it typically works to send an alert message with location which is tracked by GPS module, to a nearby police station: The GSM modem is equipped with a SIM card that allows it to connect to the GSM network operated by mobile network providers. This network provides coverage over a wide geographic area, allowing devices to communicate via SMS, voice calls, and data services [5]. When triggered, such as by a distress signal from a safety device (like a women's safety bag), the GSM modem's integrated software or firmware processes the request to send an alert message. The alert message is typically pre-configured to be sent to predefined recipients, such as the phone number associated with the nearby police station or a dedicated emergency response service. The GSM modem converts the alert message into SMS format, which consists of structured data packets suitable for transmission over the GSM network. This format includes the recipient's phone number, the message content, and any necessary routing information. The GSM modem communicates with the nearest GSM tower within range. It establishes a connection and transmits the SMS data to the mobile network operator's infrastructure. The mobile network operator routes the SMS message to the recipient's network (in this case, the police station's network). The recipient's network then delivers

the message to the specified phone number associated with the police station. Upon receiving the SMS alert, personnel at the police station are notified of the distress signal and the location details (if included) provided by the sender (such as the GPS coordinates from a GPS-equipped safety device). Upon receiving the alert, the police station can initiate appropriate response actions, dispatch personnel to the location, and provide assistance to the individual in distress [6]. Key considerations for the effectiveness of using a GSM modem for sending alert messages include network coverage, SIM card validity and credit (if applicable), and the reliability of the modem itself. These factors ensure timely communication of emergency situations to designated recipients, facilitating swift response and assistance when needed. Upon activation of the pressure sensor, the bag's buzzer emits a loud alarm sound. This serves multiple purposes. The buzzer in safety devices works as an audible alarm to alert the victim's surroundings when activated. A buzzer is an electronic component that converts electrical energy into sound energy. It typically consists of a small electromechanical device that produces a buzzing or beeping sound when powered. A pressure sensor being activated (as previously discussed), or another predefined signal indicating danger. When activated, the buzzer receives an electrical signal from the safety device's circuitry. This signal causes the buzzer to vibrate at a specific frequency, generating a loud sound that is easily audible to people nearby. The primary purpose of the buzzer is to attract attention to the situation. By emitting a loud and distinct sound, the buzzer alerts people in the vicinity that someone is in distress or danger. The Buzzer sounds deters potential attackers by drawing attention to the situation and provides reassurance to the victim that their distress signal has been activated and help is being summoned. In some designs, users may have control over the buzzer's activation, such as silencing it

after activation or adjusting its settings based on personal preference or specific scenarios. In summary, the buzzer in a safety device serves as a crucial component for alerting and notifying the victim's surroundings of an emergency situation, thereby enhancing safety and facilitating prompt assistance [7]. Alerts the surroundings to the presence of a potential threat or distress situation. The bag may also include manual controls, such as a panic button or another mechanism for the user to initiate the distress signal manually in case of emergency. Ensuring the bag has a reliable power source (e.g., rechargeable battery) and connectivity (e.g., cellular network or satellite communication) is crucial for continuous operation and effectiveness in various environments. Overall, this methodology combines advanced technology (GPS tracking, alert messaging) with practical features (pressure sensor, buzzer alarm) to enhance women's safety by providing swift and effective communication of distress signals to authorities and nearby contacts.

## 5. COMPONENT DESCRIPTION

In our proposed model, we show a complete block diagram (Fig: 1) of the system where we use some components. At first we use a Pico Buzzer which is a small, lightweight and cost effective piezoelectric buzzer typically used in electronic projects and devices for sound signalling purposes. These buzzers require minimal power to operate than other buzzers. These buzzers can produce a range of sounds from simple beeps to complex tones, depending on the signal they receive. This makes them useful for various application such as alarms, notifications and audio feedback, the buzzer shown in Fig: 3. Second component is GPS Neo-6m (shown in Fig:4) which is a GPS module widely used in various navigation and tracking applications due to its high performance and reliability than any other modules.

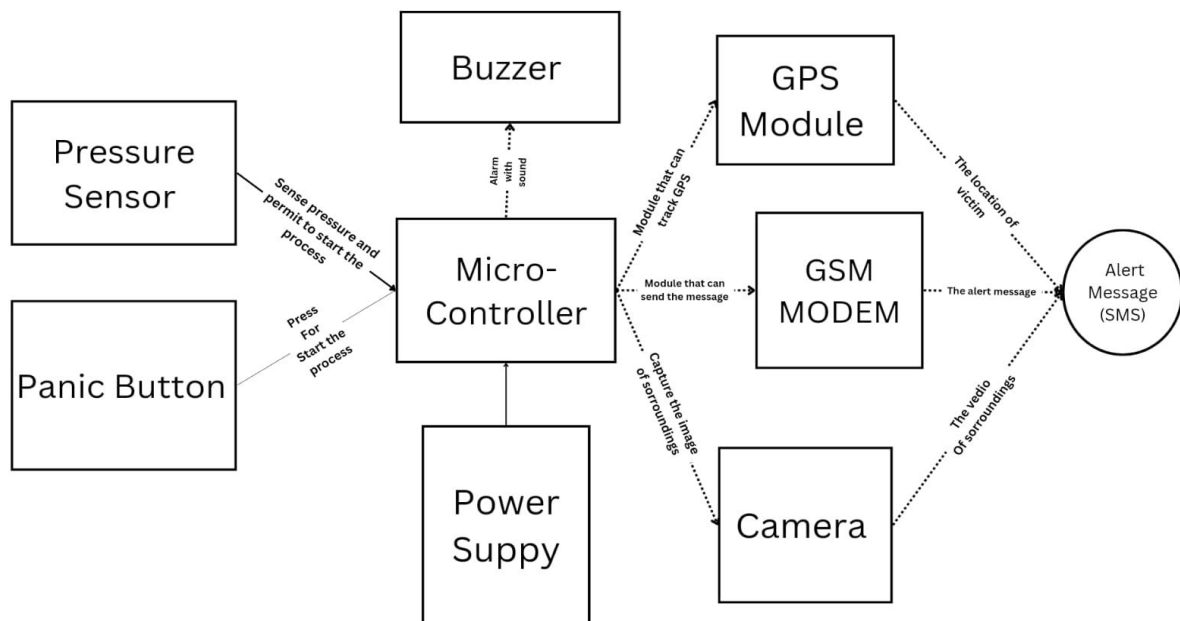


Fig 1: Block diagram of a Women safety bag.

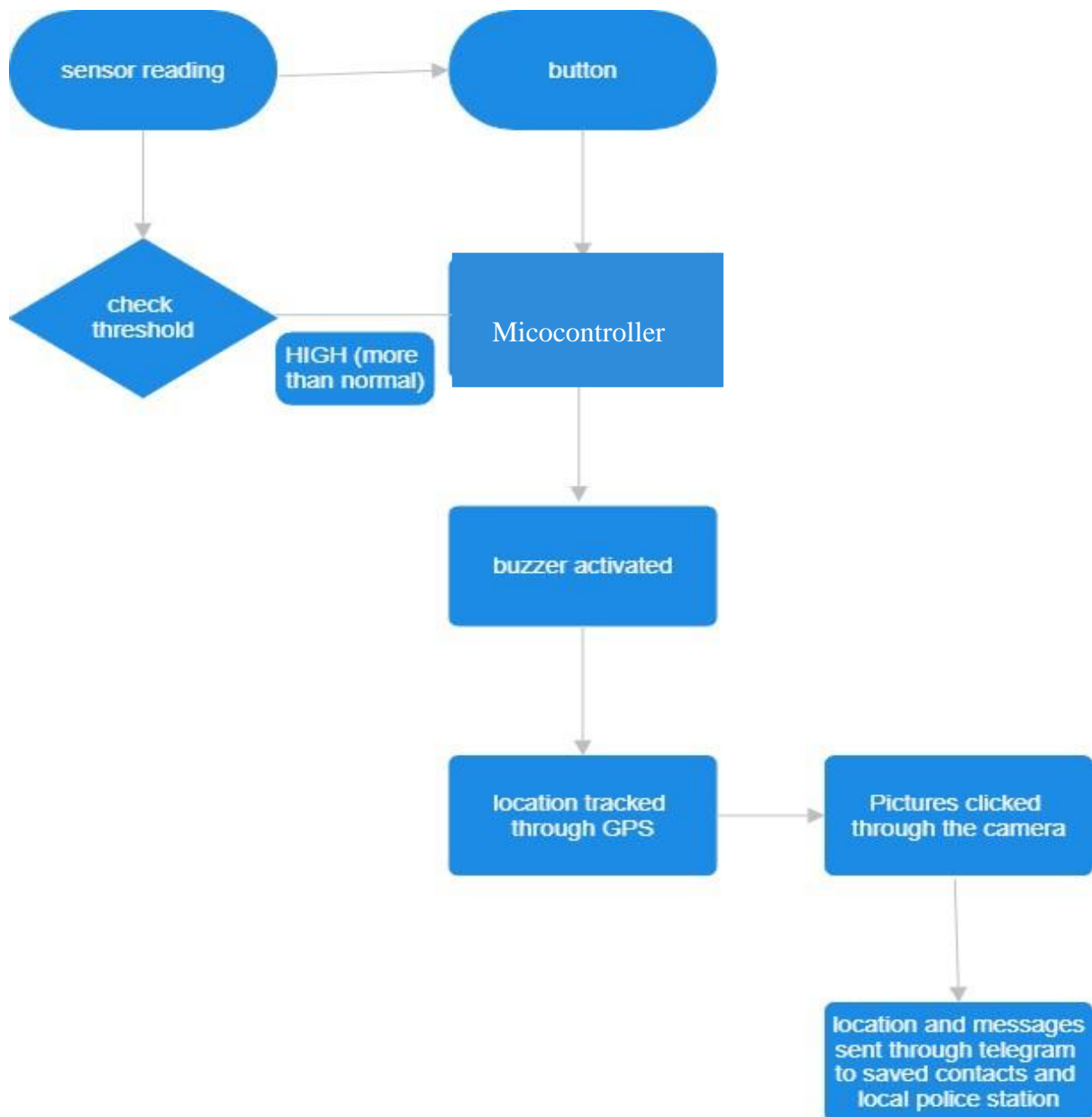


Fig 2 : Flow Chart of Our proposed model .

This module gives a proper location and accurate positioning. This module designed to be power-efficient. The neo-6m communicates with microcontrollers via serial communication (UART) [8]. The third component is GSMSIM900A (shown in Fig: 5) which is a GSM/GPRS module that provides a reliable way to add wireless communication capabilities to various electronic projects and devices. The SIM900A supports dual-band GSM networks. It supports GPRS for internet connectivity, enabling data transmission

over mobile networks. This module can handle SMS (Short Message Service) and voice calls, facilitating a wide range of communication application. As per our flowchart in Fig: 2, a pressure sensor (Fig: 6) integrated into a women safety bag is vital component designed to enhance personal security. This sensor can detect unusual or sudden pressure changes on the bag, such as when its grabbed forcefully or tampered with. The primary function is to trigger an alert or initiate a safety protocol in response to these pressure changes [9]. A push button (Fig: 7) integrated into a women safety bag serves as a straight

forward yet effective user interface element for activating emergency features or alerts. This button is strategically placed for easy access, allowing the user to carefully trigger action in potentially dangerous situations. The ESP32-CAM (Fig: 8) is a versatile module combining an ESP32 microcontroller and a camera, making it a powerful addition to a women safety bag for enhancing security and situational awareness. This module includes a camera capable of capturing images and video, providing visual evidence in case of emergencies and incidents.



Fig 3: A Piezoelectric Buzzer.



Fig 5: GSMSIM900A



Fig 6: Pressure sensor.



Fig 7: Push button

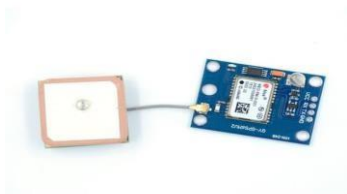


Fig 4: GPS Neo-6m



Fig 8: ESP32-CAM Module



## 6. Result and discussion:

The women safety bag, designed to enhance personal security, integrates several innovative features such as GPS tracking, an emergency alarm, and quick-access compartments for self-defence tools. A significant number of users reported feeling safer while carrying the bag, especially in unfamiliar or potentially dangerous environments. The intuitive design and accessibility of the safety features received positive feedback, with many users appreciating the simplicity of activating the alarm and GPS functions. The durability and reliability of the bag's components, particularly the alarm system and GPS tracker, were praised for consistent performance during testing. The alert message sends through the message to the nearby police station or family of victim (shown in Fig: 9) the police and family can get the information about incident (shown in Fig: 10).

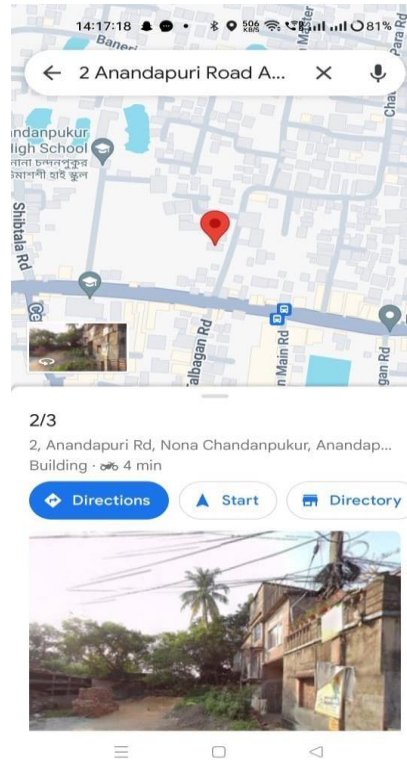


Fig 10: The link is opened on Google maps and shows the place where the incident happened. This is shown in fig 10.

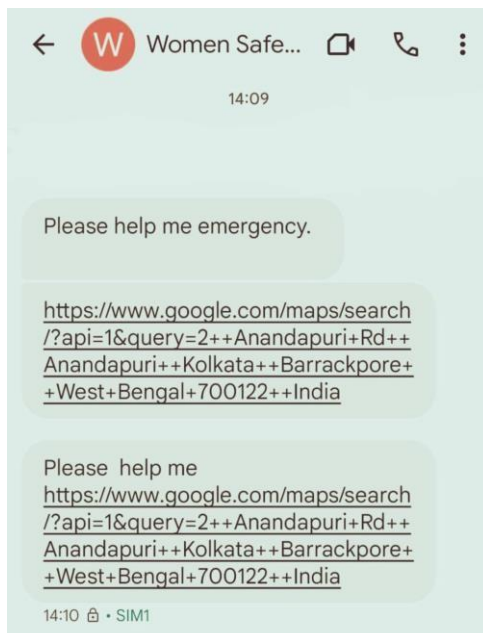


Fig 9: The alert message sends through the message with the location via link.



Fig 11: This is our proposed solution.



Fig 12: This is the side view of the bag where the whole system was proceeding.

The development and deployment of the women safety bag underscore the importance of integrating technology into personal safety products. Besides all the functionality of the bag (shown in Fig :11), it is lightweight and body friendly. The components used in the entire system has negligible weight that doesn't cause any over weight to the bag exclusively. They are stylishly designed that goes with the generation's trends making it more comfortable to use. The positive user feedback indicates a successful blend of functionality and user-friendliness. However, some areas for improvement were noted. Enhancing the battery life of the GPS and alarm systems could further improve the bag's reliability. Offering different styles and sizes could cater to a broader range of preferences and needs. Reducing the production cost without compromising quality could make the bag more accessible to a wider audience. Overall, the women safety bag represents a significant step forward in personal security solutions, combining practical design with advanced technology to enhance safety for women in various settings.

## 7. Conclusion:

Women's safety bags often incorporate features such as slash-resistant straps, locking zippers, and RFID-blocking pockets to prevent theft and unauthorized access to personal belongings [10]. Some bags are equipped with panic buttons or devices that can send distress signals to emergency contacts or authorities, enhancing personal safety in threatening situations. Advanced safety bags may integrate GPS tracking technology, allowing users to share their location in real-time with trusted contacts or emergency responders. High-quality materials like ballistic nylon or leather are used to ensure durability and longevity, providing reliable protection against wear and tear. Despite the focus on safety features, manufacturers prioritize user comfort and convenience by ensuring the bags are lightweight, ergonomic, and stylish. The women safety bag stands out as a unique and innovative product due to its focus on enhancing personal safety. Unlike standard bags, it incorporates features specifically designed to protect and alert. These features may include built-in alarms, GPS tracking, hidden compartments, and quick-access mechanisms for self-defence tools. The combination of these elements not only provides practical utility but also offers peace of mind, making it a pioneering solution in the realm of personal security. This thoughtful integration of technology and design underscores its distinctiveness and effectiveness in addressing safety concerns. The market for women's safety bags is growing, driven by increasing awareness of personal safety issues and demand for practical solutions that blend seamlessly into everyday life.

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