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EMPOWERING WOMEN'S SAFETY WITH SMART IOT TECHNOLOGY: A ROBUST PROTECTION SYSTEM

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ABSTRACT
Women's safety is a growing global concern, and to address this, we propose an advanced Women's Safety System, a compact, portable device that integrates modern technology to provide immediate assistance in emergencies. Powered by an Arduino UNO microcontroller, the system coordinates several components, including a GSM module (SIM900A), GPS module (Neo-6M), an ESP camera for live video streaming, a buzzer, an electric shock mechanism for self-defense, and an LCD display for status updates. Activated by a Panic Button, the system simultaneously sends the user's location via SMS to predefined contacts, streams live video for real-time situational awareness, and triggers a loud buzzer to alert nearby individuals. Additionally, the electric shock feature provides a non-lethal deterrent to attackers, allowing the user to escape. This multi-layered approach to safety combines communication, location tracking, and self-defense, making it a reliable, portable solution to enhance women's security and ensure rapid emergency responses.
Keywords: Arduino UNO, GSM, GPS, ESP Camera, Panic Button, Electric Shock, Live Video Sharing.

I. INTRODUCTION
Women's safety is a pressing global issue, with increasing reports of harassment, assault, and violence in public and private spaces (UN Women, 2023). Despite legislative measures and awareness campaigns, traditional safety mechanisms—such as self-defence training, emergency help lines, and mobile applications—often fail to provide real-time, automated protection (Kishore, 2023). Many existing solutions rely on manual activation, internet connectivity, or bystander intervention, making them ineffective in high-risk scenarios where immediate response is crucial (Paul et al., 2023). To bridge this gap, this study introduces an IoT-based Smart Women's Safety System that integrates real-time tracking, automated emergency alerts, live video surveillance, and active self-defence mechanisms to ensure rapid and reliable protection.
The proposed system leverages Arduino UNO, GSM (SIM900A), GPS (Neo-6M), ESP32 camera, panic button, electric shock module, and buzzer alarm to create a multi-layered security framework**.** Upon activation, the device instantly sends GPS coordinates via SMS to predefined emergency contacts, initiates an automated distress call, captures live video footage for evidence, and activates a high-decibel alarm to deter attackers (Ananthula et al., 2023). Additionally, the inclusion of an electric shock mechanism provides an active self-defence option, enhancing personal security beyond passive alert systems. This research contributes to the field of IoT-based safety solutions by addressing key limitations in existing technologies, such as delayed response times, lack of real-time situational awareness, and insufficient self-defence capabilities. The system's compact, wearable design ensures portability, making it suitable for everyday use in urban and remote environments. By combining automation, real-time communication, and active protection, this innovation offers a proactive, reliable, and scalable approach to women's safety, empowering individuals with immediate security measures in life-threatening situations.

II. LITERATURE
a. Evolution of Women's Safety Technologies Women's safety technologies have evolved from basic emergency help lines to smart IoT-enabled devices. Early solutions, such as panic buttons and mobile apps, were limited by their dependence on manual activation and network connectivity

(Kishore, 2023). Studies indicate that 60% of emergency apps fail in low-network areas, leaving users vulnerable (GSMA, 2022). To overcome this, researchers introduced wearable GPS trackers that send location-based alerts (Paul et al., 2023). However, these systems lacked real-time video evidence and active defence mechanisms, reducing their effectiveness in emergencies.

b. **IoT and Embedded Systems in Safety Devices**: Recent advancements in IoT and embedded **systems** have enabled more robust safety solutions. Ananthula et al. (2023) developed an Arduino-based GPS alert system that sends distress signals via GSM, but it lacked live video streaming and self-defense features. Similarly, FEMME, an ARM-based safety device, integrated GPS and SMS alerts but did not include automated calling or electric shock mechanisms (IJCRT, 2018). These gaps highlight the need for a multi-functional system that combines real-time tracking, communication, and active protection.

c. Limitations of Existing Systems Despite advancements in technology, current safety devices still face several key challenges. One major limitation is their dependence on third-party response, such as police or bystanders, which often leads to delays in assistance (Kishore, 2023). Additionally, many systems lack the ability to collect real-time evidence, as few incorporate cameras for situational awareness, limiting their effectiveness in emergencies (Paul et al., 2023). Furthermore, most devices lack built-in self-defense mechanisms, relying solely on passive alarms that may prove ineffective if no one is nearby to respond (GSMA, 2022). These limitations highlight the need for a more comprehensive and immediate solution to personal safety.

d. **Proposed Advancements in This Study** : This research overcomes the limitations of existing safety systems by introducing several innovative advancements. The system features Automated GSM Calling & GPS Tracking, which ensures an instant emergency response even in the absence of internet connectivity. Additionally, the Live ESP32 Camera Feed enables real-time video evidence, providing law enforcement with crucial situational awareness during emergencies. The inclusion of an Electric Shock Mechanism offers active self-defence against attackers, enhancing the user's ability to protect them. Finally, the **Compact & Wearable Design** ensures the device is portable and easy to use, making it an effective and practical solution for personal safety. These advancements collectively improve response time, situational awareness, and self-defence capabilities.

e. **Research Gap and Contribution:** While prior studies have explored GPS-based alerts and wearable safety devices**,** none have integrated real-time video streaming, GSM-based automated calls, and electric shock mechanisms into a single system. This research fills that gap by developing a comprehensive, IoT-enabled safety device that ensures immediate response, evidence collection, and active defence, significantly improving women's security in emergencies

III.METHODOLOGY

The methodology for this research adopts an experimental and iterative development approach to design and implement an advanced IoT-based women's safety system. The study begins with a thorough problem analysis, identifying critical gaps in existing safety solutions, such as the lack of real-time situational awareness, absence of self-defence mechanisms, and delayed emergency responses due to third-party dependencies. Based on these findings, the system requirements are defined to include real-time GPS tracking using the Neo-6M module, automated GSM alerts via the SIM900A module, live video surveillance through the ESP32-CAM, an active self-defence mechanism with an electric shock module, and a portable, wearable design for user convenience.

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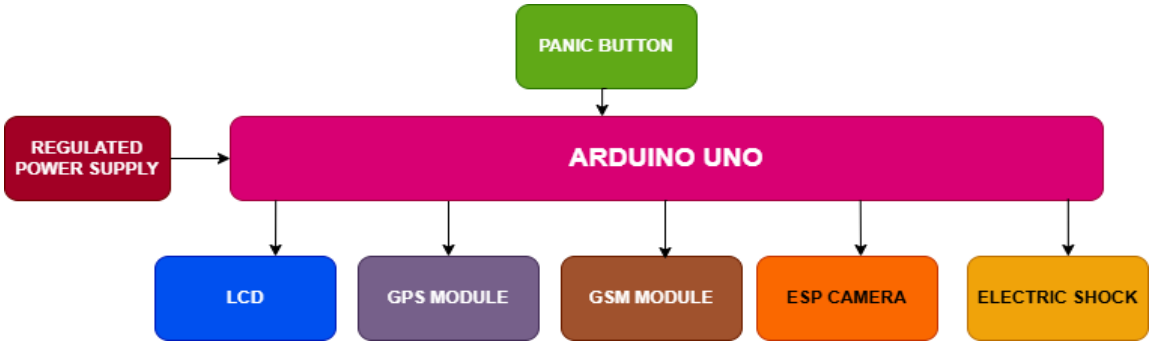

Fig 3.1: System architecture

The system architecture is structured into four layers: the input layer, which includes a panic button and optional motion sensors; the processing layer, comprising the Arduino UNO microcontroller and ESP32-CAM for video processing the communication layer, featuring GSM and GPS modules for alerts and location tracking and the output layer, which integrates a buzzer, electric shock module, and LCD display for status updates.

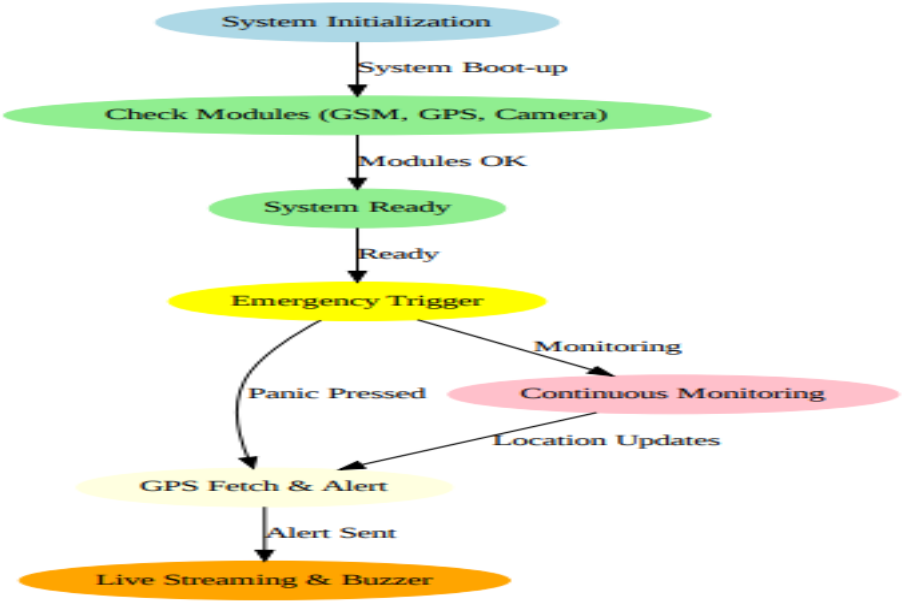

Fig 3.2: Work flow of proposed Diagram

The hardware implementation involves carefully selected components, such as the Arduino UNO for central processing, the SIM900A GSM module for SMS and call alerts, the Neo-6M GPS module for precise location tracking, and the ESP32-CAM for live video streaming. A 20,000mAh power bank ensures portability, while a tactile switch serves as the panic button for emergency activation. On the software side; the system follows a structured algorithm workflow. Upon initialization, the system checks all modules and displays a "System Ready" message on the LCD. When the panic button is pressed, the Arduino triggers multiple simultaneous actions: the GPS fetches real-time coordinates, the GSM module sends SMS alerts and initiates automated calls to emergency contacts, the ESP32-CAM starts live video streaming, the buzzer sounds to attract attention, and the electric shock module arms for self-defence. Continuous monitoring ensures GPS updates every 10 seconds, and the camera records until the system is manually deactivated. Key software modules include GPS data parsing using the TinyGPS++ library, GSM communication via AT commands, and Wi-Fi-based live streaming through the ESP32-CAM.Testing and validation are conducted to ensure system reliability. Functional tests confirm that the panic button activation sends SMS and call alerts, the ESP32-CAM provides a live video feed, and the electric shock module operates as intended. Performance metrics indicate a response time of less than five seconds, GPS accuracy within ±2.5

meters, and a battery life of approximately 48 hours with a 20,000mAh power bank. A comparative analysis highlights the advantages of the proposed system over existing solutions, such as its ability to provide real-time alerts, self-defence features, and live video evidence without relying on internet connectivity.In conclusion, this research contributes a comprehensive, IoT-based safety solution that addresses the limitations of current systems. Future enhancements may include AI-based threat detection for proactive security, blockchain integration for secure and immutable alert logs, and solar-powered designs for sustainability. The methodology ensures a robust, scalable, and user-centric approach to improving women's safety in emergencies.

IV RESULTS

System Initialization: When the system is powered on, the LCD screen displays "GSM&GPS Based Women Safety …"**,** signalling that all essential components, including GSM, GPS, and other modules, have been successfully initialized. This display assures the user that the system is operational and ready for use. The initialization process ensures that all connections are stable before further actions can be performed.

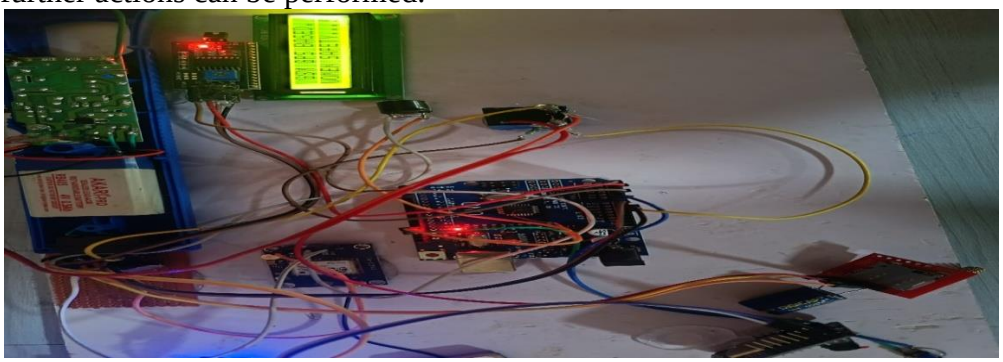

Fig 4.1: System Initialization

Emergency Activation: In a distress situation, pressing the panic button sends an immediate signal to the Arduino microcontroller. Upon receiving this signal, the Arduino promptly activates emergency mode, triggering various safety features. The LCD updates its display to "PANIC BUTTON ACTIVATED…" confirming the activation. This step is crucial as it ensures that the emergency mode is engaged, alerting the system to take the next steps in securing the user's safety**.**

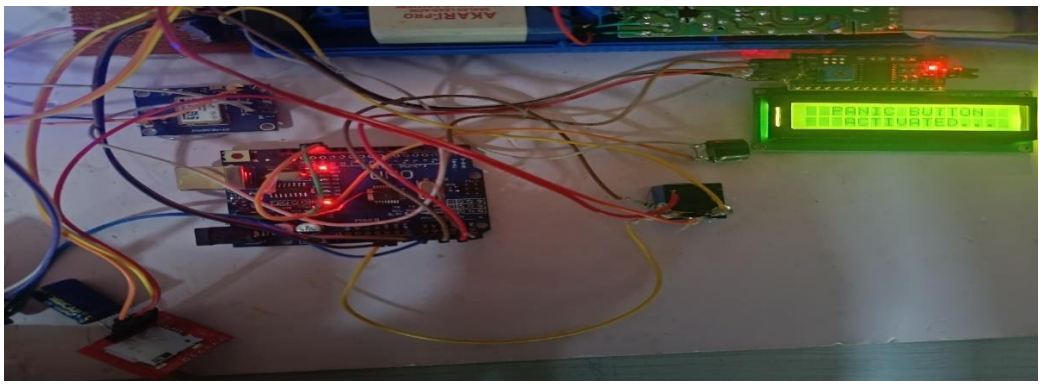

Fig 4.2: Panic Button Activation

Location Tracking Mechanism: Once the emergency mode is activated, the system sends a command to the GPS module to fetch the user's exact coordinates. The module retrieves latitude and longitude values and transmits them back to the Arduino for processing. The obtained coordinates are displayed on the LCD for verification, ensuring that the location data is successfully captured. This real-time tracking mechanism helps emergency responders quickly pinpoint the victim's exact location.

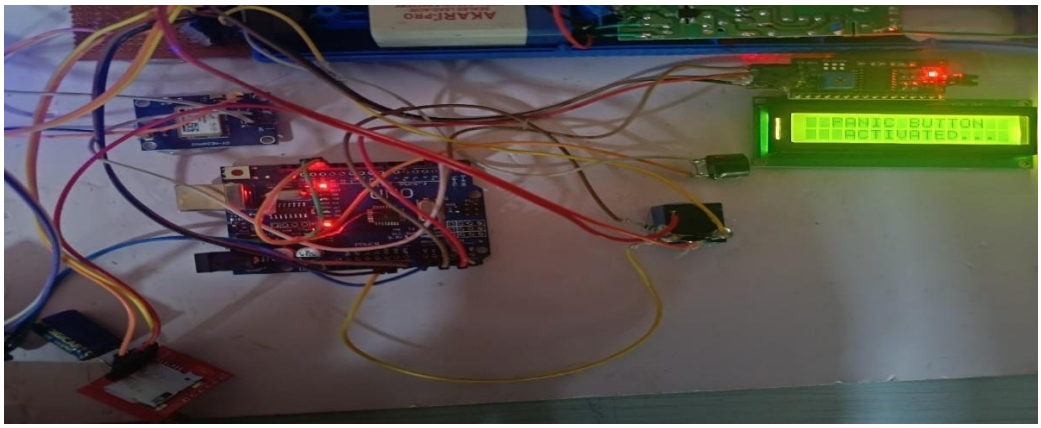

Fig 4.3: User Location Coordinates

Alert Message Mechanism: The Alert Message Mechanism plays a crucial role in ensuring immediate assistance during emergencies. Once the panic button is activated, the Arduino microcontroller processes the real-time GPS coordinates and formulates an emergency SMS alert. This message is then transmitted through the GSM module to a pre-registered contact, such as a family member or emergency responder. The alert contains essential details, including a panic notification that signals distress, the exact latitude and longitude coordinates for precise location tracking, and a Google Maps link that allows responders to navigate directly to the user's position. By automating this process, the system significantly reduces response time, ensuring that help reaches the victim as quickly as possible.

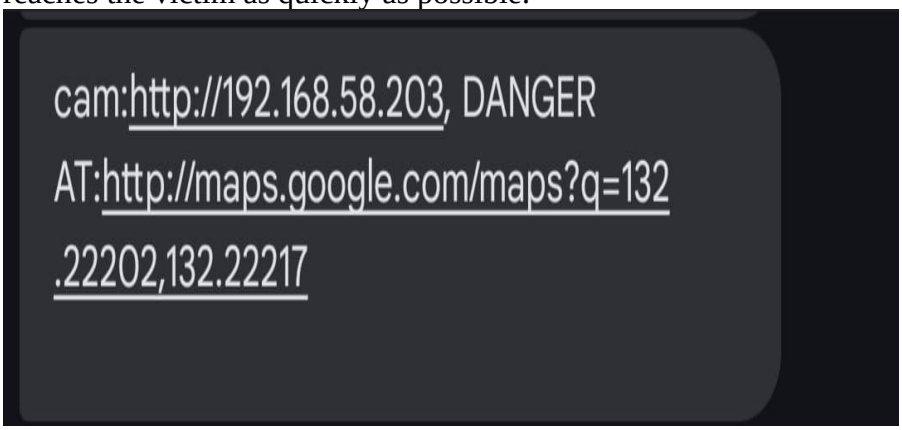

Fig 4.5**:** Alert Message

Live Video Transmission Mechanism: For real-time monitoring, the Arduino activates the ESP32-CAM module**,** which starts capturing live footage. The video stream is transmitted either via a local IP or a cloud-based service**,** allowing a trusted recipient to view the situation remotely. This feature enhances the safety system by providing visual confirmation of the emergency, allowing responders to assess the severity of the situation and take appropriate action.

V. CONCLUSION

The Women Safety System is a technologically advanced solution designed to address the critical issue of women's security. By integrating GPS tracking, GSM alerts, live video streaming, a self-defense shock module, and an emergency buzzer, this system provides a multi-functional and real-

time protection mechanism. With a single press of the panic button, users can activate self-defense measures, instantly share their live location, send emergency SMS alerts, stream live video, and trigger a loud alarm to alert nearby individuals. This multi-layered approach enhances personal security by ensuring immediate response and communication in distress situations. Its compact and portable design makes it easy to use, offering a practical and reliable safety tool for women in various environments. By leveraging advanced technology, this system significantly improves emergency response times, providing a life-saving solution that empowers women with real-time protection and assistance, ultimately contributing to a safer world.

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