SafeShe: IoT-Enabled Women Security and Well-Being

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Abstract: Ensuring the safety of women in vulnerable situations is an imperative societal concern. Women are particularly at risk when traveling alone on deserted roads, making their safety a critical issue that affects their daily lives, limits their mobility, and restricts their opportunities. Threats such as street harassment, cyberbullying, domestic violence, and workplace exploitation continue to endanger their security. This proposed project introduces an IoT-based Women's Safety Device, a portable and user-friendly system designed to provide immediate assistance during emergencies. The device integrates GPS technology, a live camera module, and a communication system to deliver real-time location tracking, visual evidence, and automated alert notifications to emergency contacts and law enforcement authorities. Unlike existing systems, our project features an enhanced video-capturing capability, ensuring comprehensive monitoring and response.

1 INTRODUCTION

Women's safety is a significant topic of discussion in today's society, as incidents of harassment, violence, and unsafe situations continue to occur in different parts of the world. Despite laws and security measures, many women still face challenges in ensuring their safety, especially in unfamiliar or high-risk environments. Factors such as lack of immediate assistance, difficulty in reporting incidents in real-time, and delayed responses from authorities often make these situations worse. Public spaces, workplaces, and even homes can sometimes become unsafe, highlighting the need for reliable safety solutions. Figure 1 illustrates the Women Safety issues.

More than 75% of women reported feeling unsafe while commuting alone at night, especially in poorly lit areas. One of the biggest problems pointed out was law enforcement response time, with more than 60% of the survey respondents unhappy with emergency services. Poor knowledge of existing safety technology was another concern expressed by the surveyed women, as many are oblivious to the presence of mobile apps or IoT-based solutions to help in case they are in distress. The survey also reiterated issues of accessibility as over 40% of women stated that in a dangerous situation, they may not always be able to lay their hands on a smartphone or an active internet connection. The second highlighted issue concerned privacy and data security, with respondents fearing that their personal data in tracking-based systems could be misused. Social factors, such as stigma for reporting harassment or fear of not being taken seriously, can deter women from seeking assistance.

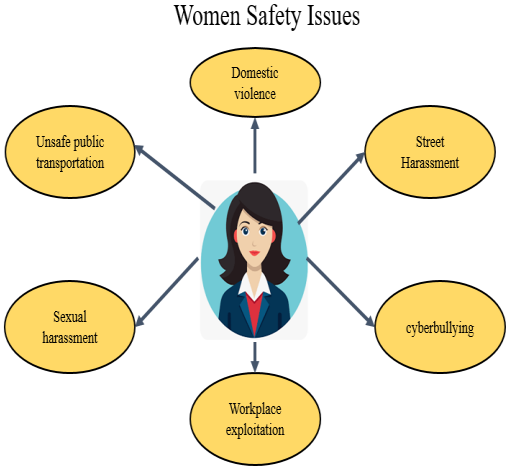

Figure 1: Women Safety Issues.

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The system is activated by pressing a button, which immediately triggers multiple safety measures. It sends an alert message along with real-time GPS location updates to emergency contacts, police, and law enforcement authorities. Simultaneously, a buzzer emits a loud alarm sound to alert nearby individuals and deter potential threats. Additionally, the device captures live video footage and transmits it to authorities, providing crucial evidence for a faster and more effective response. With these integrated features, the device aims to enhance security, ensure timely intervention, and offer a dependable solution for women's safety.

2 LITERATURE REVIEW

Monika Ingole et al., (2024) Temperature sensor, accelerometer, GPS, GSM, buzzer tracks movement, sends alerts, and activates an emergency buzzer. This system features as Real-time Tracking, Emergency Alerts, Temperature Monitoring. (Pratiksha S. Patil et al., 2024) Heartbeat sensor, bend sensor, Arduino, GSM monitors heart rate fluctuations and sends emergency calls/messages with location Real-time Health & Movement Monitoring, Automatic Emergency Alerts, Quick Medical Response & Safety. Janani S et al., (2024) AI- Tensilica Controller, accelerometer, iBeacon, cloud server detects shaking, triggers alerts, and continuously tracks via cloud. This advanced integration improves-Powered Smart Response Continuous Tracking & Cloud Storage.

Pallavi Devendra Deshpande et al., (2024) Arduino, GPS, GSM, vibration alert continuously tracks location, sends alerts, and warns nearby people with sound/vibration. The system provides, Instant Alerts& Communication. Immediate Warnings for Safety. (Hrucha Wankhade et al., 2022) GPS, GSM, WiFi ESP8266, shock mechanism sends location, stores pulse rate in the cloud, and can shock an attacker. This advanced integration improves as Instant Emergency Alerts,Self-defense Mechanism ,Real-time Tracking & Cloud Storage.(N. Penchalaiah et al., 2024)Alarm system, voice recognition automatically issues an alarm and uses voice commands for emergency assistance. Include this advance for, Hands-free Emergency Activation, Enhanced Safety & Accessibility.

C K Gomathy, Ms.S.Geetha Arduino, panic switch, laser diode, buzzer sends manual alerts, shocks attackers, and activates a buzzer with a laser diode. This system features as Instant Emergency Alerts, Self-defense Mechanism, Multi-layered Warning System. (Garima Tiwari et al., 2020) Fingerprint scanner, GPS, GSM, buzzer requires authentication, sends location if not scanned every minute, and alerts surroundings. This advanced system ensures, Enhanced Security with Authentication, Automatic Emergency Alerts & Tracking, Immediate Surrounding Alerts, Enhanced Safety & Anti-kidnapping Protection, Remote Safety Monitoring.

Riddhi Shah, Miloni Ganatra., (2018) Heartbeat sensor, GSM, GPS continuously tracks heart rate and sends location via GSM if abnormal readings are detected. Include the advance for Location Tracking for Quick Response, Automatic Emergency Alerts, Prevention of Medical Emergencie**s,** Ideal for High-risk Individuals. (D. G. Monisha et al., 2016) Android app, ARM controller, Bluetooth, RF detector syncs with a smartphone, tracks location, records audio, and detects hidden cameras. This system feature as Smartphone Integration & Control, Multi-functional Security System, Real-time Alerts & Detection (Ashutosh Agrahari et al., 2024) IoT, Artificial Intelligence (AI), and biosensors in a wearable device to provide real-time health monitoring and personal security for consumers. This system features as Enhanced Personal Security, AI-powered Smart Analysis, Real-time Health Monitoring.

(Uzma Omer et al., 2023) IoT, sensors, GPS, GSM, AI, and cloud computing for enhancing women's safety by enabling real-time monitoring, emergency alerts, and secure data storage for quick response and prevention. This system features as Secure Data Storage & Evidence Collection, Instant Emergency Alerts & Location Tracking, Real-time Monitoring & Threat Detection (V. Ramesh babu et al., 2021) GPS, GSM, sensors, and alert systems for enhancing women's safety by enabling, emergency communication, and automated threat detection. This system featurse as Quick Emergency Communication, Automated Threat Detection, Proactive Safety Measures.

T. Sowmya et al., (2020) GPS, sensors, microcontrollers, and cloud computing for women's safety. The system enables real-time tracking, emergency alerts, and data storage for quick response and prevention of threats. This advanced integration improves as Secure Data Storage & Analysis, Instant Emergency Alerts, Fast & Reliable Response System (T.P. Suma G. Rekha., 2021) IoT, sound sensors for screaming detection, video capturing, automatic distress alerts, video evidence collection, and emergency response activation to enhance personal security. This system features as Automated Threat Detection & Response, Evidence Collection for Legal Support, Live Monitoring & Remote Access,

Automated Emergency Response Real-time Video Evidence Collection, Instant Emergency Activation.

3 METHODOLOGY

3.1 Block Diagram

- **Arduino UNO**(ATmega328P): acts as the main controller, interfacing with sensors, the IoT module, and other components as shown in figure 2.
- **GPS Module (Neo-6M):** captures the real time location coordinates and sends it.
- **IoT module (**NodeMCU ESP8266): provides Wi-Fi connectivity to transmit updates to the IoT Cloud app.
- **Buzzer:** sounds to alert nearby individuals about the distress situation.

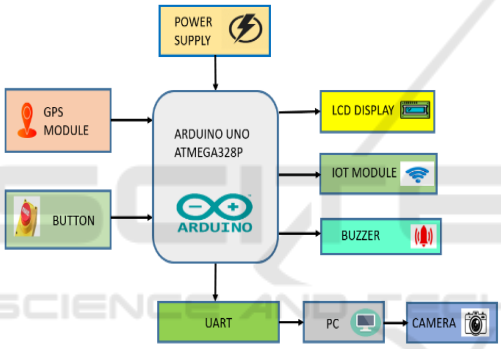

Figure 2: Block Diagram.

- **LCD Display***:* displays system status.
- **Camera:** captures the video during the emergency and sends them.
- **Button:** Pressing the emergency button activates the entire safety protocol.
- **Power Supply Unit**: Provides the necessary voltage and current to operate.
- **UART Cable:** Universal Asynchronous Receiver-Transmitter facilitates serial communication between the Arduino and other devices like the PC.
- **PC:** Personal Computer acts as an interface for data processing, storage, or cloud integration to enhance system capabilities.
- **Arduino Ide 1.8.19***:* Arduino IDE 1.8.19 is a stable, user-friendly environment for writing, compiling, and uploading Embedded C code to Arduino boards like the Uno (ATmega328P).
- **Python IDLE 3.12**: Python IDLE 3.12 enables writing and executing Python code to capture and transmit live video during emergencies, sending footage to law enforcement or emergency contacts.
- **IoT Cloud app***:* IoT Cloud app enables real-time monitoring, sending alerts, and displaying the GPS location and emergency status on the user's phone.

3.2 Implementation

When the user presses the emergency button, multiple actions are triggered simultaneously. The buzzer is activated, producing a loud alarm sound to alert people nearby and deter potential threats. Simultaneously, the system obtains the real-time GPS location and transmits it to emergency contacts, law enforcement authorities, and an IoT cloud platform for tracking. An alert message is sent with location details to ensure a quick response. Additionally, the camera module captures live video footage and sends it to the authorities as evidence. Figure 3 illustrates the methodology diagram.

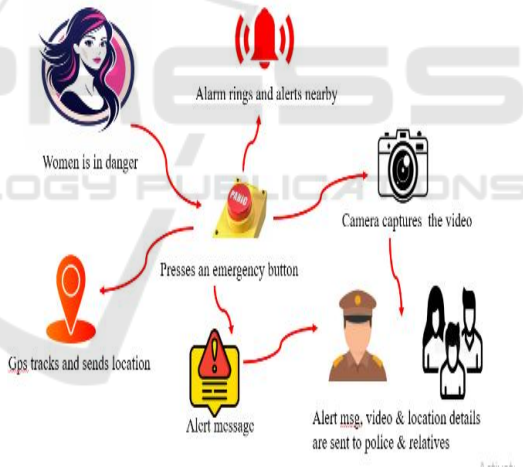

Figure 3: Methodology.

The system effectively performs the following functions upon pressing the emergency buttons.

- **Buzzer Activation** – The buzzer emits a loud alarm sound, which alerts nearby individuals, helping to draw attention and deter potential threats.
- **GPS Location Transmission** – The system accurately captures the user's real-time location and sent it via an alert message to emergency contacts and law enforcement authorities. The GPS coordinates were precise and will update in real-time.

- **Alert Message Delivery** – The emergency alert message containing location details will be sent to predefined contacts and authorities, ensuring immediate response.
- **Video Transmission** – The camera module successfully records and transmits real-time video footage to the police, providing crucial evidence for quicker action.

The demonstration of this system proved that combining real-time safety mechanisms with the IoT can provide improved biological health response time." Traditional mobile-based safety applications generally required time-consuming steps to unlock a phone and reach use the app, while this use case benefits from one point activation of a dedicated safety device, making it far more practical in critical moments. In summary, the IoT-based Women's Safety Device is a cost-effective, scalable and user-friendly solution for improving the safety of women in society. This system could become a key safety instrument for practical applications with further refinements.

3.3 Random Forest Algorithm for Women Safety

Random Forest is an ensemble learning algorithm that combines multiple decision trees to improve prediction accuracy.

3.4 Formula for Decision Trees in Random Forest

Each decision tree makes a prediction, and the final output is determined by majority voting (for classification) or averaging (for regression).
For classification:

$$\text{Prediction} = \arg\max_{k} \sum_{i=1}^{n} 1\,(y_i = k) \qquad (1)$$

where:

- k is the class label (safe/unsafe),
- n is the number of trees in the forest,
- yi is the predicted class from the i th tree.

For a decision tree node split, we use the Gini Index:

$$\text{Gini(D)} = 1 - \sum_{i=1}^{c} p_i^2 \qquad (2)$$

where:

- pi is the probability of class i,
- c is the number of classes.

3.5 How It Works in Women's Safety IoT Devices

Random Forest can be used in the IoT-based Women's Safety Device to enhance threat detection and decision-making. It can analyze real-time data from the device and predict whether the situation is safe or unsafe based on historical patterns and input features.

Step 1. Data Collection & Features Used
The model can use multiple features to detect potential threats, such as:

- **GPS Data** – Analyzing whether the location is in a high-risk area based on past crime data.
- **Time of Day** – Identifying whether the user is in a potentially unsafe situation (e.g., late-night travel).

Step 2. Decision-Making Using Random Forest

- Each decision tree in the Random Forest model analyzes different factors (GPS, time, movement, voice).
- The model predicts whether the situation is SAFE or UNSAFE using majority voting.
- If the majority of decision trees classify the situation as "unsafe," the alert system is automatically activated.

Step 3. Gini Index for Node Splitting
The Gini Index formula is used to determine the best feature for splitting the decision tree:

$$\text{Gini} = 1 - \sum_{i=1}^{c} p_i^2 \qquad (3)$$

where:

- P_i is the probability of class ii (safe or unsafe).
- c is the number of classes.

A lower Gini Index means a better split, helping the model identify unsafe situations more accurately.

Step 4. Predicting Safety Status
For classification, the final prediction is based on majority voting

$$\text{y} = \arg\max_{k} \sum_{i=1}^{n} 1\,(y_i = k) \qquad (4)$$

where:

- k is the class label (safe/unsafe).

- n is the number of trees in the forest.
- y_i is the predicted class from the i-th tree.

If a majority of trees are predicted unsafe, a buzzer is activated, GPS and video data are transmitted to authorities, and an alert message is sound.

Incorporating Random Forest into the IoT-based Women Safety Device, this model enables intelligent predictions of potentially harmful situations and the ability to automatically send alerts, significantly improving personal safety in the present moment. By doing so we can respond proactively rather than reactively when the need arises, as opposed to waiting for an emergency to intervene manually.

4 ADVANTAGES

- **Immediate Response:** The system activates instantly, sending alerts and location data for faster emergency assistance.
- **Real Time Tracking:** GPS coordinates are transmitted live, allowing responders to locate the user without delays.
- **Local Awareness:** The buzzer and LCD notify nearby individuals, encouraging immediate help during emergencies.
- **Visual Evidence:** Captured images provide responders with valuable context, aiding faster and more informed decision-making.
- **Remote Monitoring:** IoT integration enables real-time data access through cloud platforms or mobile applications.
- **User-Friendly Design:** The system requires minimal input-a simple button press triggers the entire safety sequence.

5 CONCLUSIONS

Today's world has become a place of concern for women due to several factors like rising harassment and violence. Even when laws and security measures are in place, on-the-spot intervention is often delayed because it can be hard to report an emergency and find someone in distress. To overcome these problems the project presents an IoT based Women's Safety Device which is a portable and simple operating system that offers users immediate assistance in situations of distress.

Multiple safety features build upon one another to provide a quick and comprehensive response when this device is activated. The device button will act as the pattern activation button which will allow the user to initialize the system with a single press. When activated, a buzzer produces a loud alarm sound to attract attention from the public, in hopes that the sound will deter the attacker you are facing. At the same time, the device also records the user's GPS location and shares it with emergency contacts, law enforcement bodies, and an IoT cloud platform for tracking purpose. Moreover, a live video stream is also logged and transmitted for the authorities, forming important evidence and assisting rescue teams as well as playing a crucial role in potential legal cases.

Overall, the IoT enabled Women Safety Device is one of the most useful portable and practical safety device giving women the ability to summon emergency assistance immediately. This device not only improves personal security and accelerates law enforcement response but does so by integrating IoT technology, real-time location tracking, live video processing, and an alarm system.

6 FUTURE SCOPE

The future scope of a women's safety IoT project can be expanded with several advanced technologies to improve efficiency, accuracy, and user experience. Here are some key future enhancements:

- **Fingerprint Recognition**: Prevents unauthorized access to the safety device/app.
- **Hands-Free SOS Activation**: Voice recognition enables users to send distress signals without pressing a button.
- **AI-Based Route Optimization**: Suggests the safest route based on real-time crime data.
- **Blockchain for Secure Data Handling:** Blockchain can be used for security purposes.

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