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IoT Based Women Safety Devices with Screaming Detection and Photo Capturing

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Abstract

Women's safety is a pressing global issue, with increasing incidents of harassment and violence. Traditional safety tools, like personal alarms or manual panic buttons, often rely on user activation, which can be impractical in critical moments. This project seeks to overcome these challenges by creating an IoT-enabled wearable safety device that autonomously detects distress signals through screams, captures video evidence, and sends real-time alerts, including the user's location, to emergency contacts or local authorities. The device employs machine learning algorithms to differentiate between genuine distress sounds and background noise, ensuring accurate detection and reducing false alarms. Additional features include GPS tracking, automatic activation, and a user-friendly design, making the device practical and efficient in real-life situations. Data security and power management are key components of the system, with encryption safeguarding personal information and power-efficient components ensuring long-term functionality. This solution aims to improve women's safety by providing an intelligent, hands-free personal security option. By combining advanced IoT technologies with real-time communication capabilities, this project offers a robust, reliable, and proactive method to prevent harm, empower women, and enhance safety in public environments.

Keywords: *X-ray image, USM, CLAHE, Image enhancement, Object detection, YOLOv8.*

1. Introduction

WOMAN SAFETY DEVICE

Women's safety has emerged as a crucial issue globally, with increasing reports of harassment, violence, and assaults occurring in both public and private settings. While numerous safety measures have been introduced, such as self-defense tactics, personal alarms, and mobile emergency apps, these often fall short when immediate manual action is necessary. In high-stress situations, victims might lack the ability, time, or presence of mind to activate these tools. This highlights the need for a more efficient, automated solution that can deliver real-time assistance and enhance personal security. This project presents an innovative IoT-enabled wearable safety device designed to fill this gap by providing automatic, hands-free protection [1]. The device is capable of detecting distress signals by recognizing specific sounds, such as screams, capturing video evidence, and transmitting real-time alerts with the user's location to emergency contacts or local law enforcement [2]. Leveraging machine learning algorithms, the system can accurately differentiate between genuine distress signals and background noise, thereby reducing false alerts. Additionally, the project emphasizes the integration of GPS for precise location tracking, enabling emergency responders to quickly locate the victim [3]. The ability to record and store video evidence of incidents adds another layer of security, assisting authorities in investigations following an event. The device is designed to be lightweight, user-friendly, and energy-efficient, allowing for comfortable wear over extended periods without frequent recharging [4]. Data privacy and security are paramount,

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especially when handling sensitive information like video footage and GPS data [5]. To mitigate these concerns, the device employs encryption for all data transmissions, safeguarding personal information. It also features automatic activation capabilities, such as sensors that detect abnormal physiological changes, like elevated heart rates, further improving its autonomous response during emergencies [6].

1.1.Ease of Use

The women's safety device includes several important functions:

- **Automatic Distress Detection:** It identifies specific sounds associated with distress, like screams, without needing the user to activate it.
- **Instant Alerts:** The device immediately notifies emergency contacts or authorities, sharing the user's location in real-time [7].
- **Video Recording:** It captures video footage during emergencies, which can serve as crucial evidence for investigations.
- **GPS Location Tracking:** With built-in GPS, it provides precise location information, enabling quick response from help.
- **Ergonomic Design:** The device is lightweight and comfortable, making it easy to wear for long periods.
- **Intelligent Sound Analysis:** Machine learning algorithms help distinguish true distress signals from background noise, minimizing false alarms.
- **Data Protection:** All data transmissions are encrypted, safeguarding the user's privacy.
- **Automatic Activation Features:** It includes sensors that monitor physiological signs, such as a rapid heartbeat, to trigger the device without user action [8].

1.2.System Architecture

The system architecture for the IoT-based women safety device consists of several key components working together to ensure real-time detection of distress, video capturing, and alert notification. Below is an overview of the architecture:

1.3.Wearable Device

- **Sound Sensor:** Detects distress signals (screams) from the environment.
- **Camera:** Captures video footage when a distress signal is detected.
- **GPS Module:** Tracks and records the user's location in realtime. Microcontroller (e.g., Arduino or Raspberry Pi): Processes inputs from the sensors and controls the device's actions (sending data to the server). Communication Module (e.g., Wi-Fi or Bluetooth):
- Transmits data to the server and sends alerts.

Server/Cloud Platform:

- **Machine Learning Algorithm:** Processes the data to distinguish genuine distress sounds from environmental noise.
- **Database:** Stores video footage and GPS data securely. Alert System: Sends real-time notifications to emergency contacts and authorities via SMS, email, or mobile app.

Mobile/Control Application:

- **User Interface:** Allows emergency contacts or authorities to view the alerts, video, and location data (Figure 1).

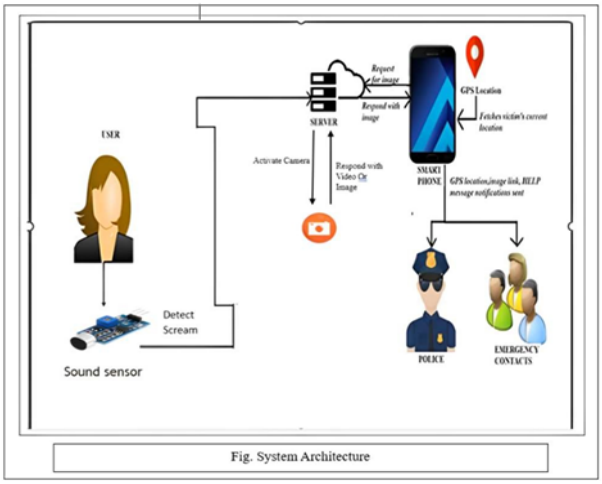

Figure 1 System Architecture

2. Units

2.1.Unit 1: Data flow Diagram

- **Level 0 DFD (Context Diagram):** Shows the interaction between the user (woman wearing the device), the wearable device, the cloud server, and emergency contacts/authorities.
- **Inputs:** Distress signals (screams) and GPS data from the wearable device.
- **Processes:** Sound detection, video capturing,

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and alert notification via cloud processing.

- **Outputs:** Real-time alerts and location data sent to authorities and emergency contacts (Figure 2).

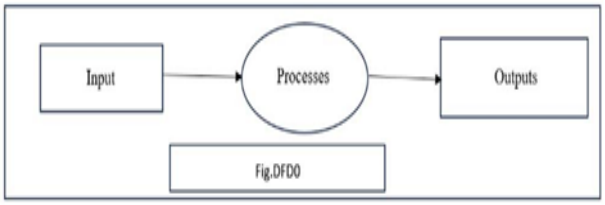

Figure 2 DFD0

Level 1 DFD: Breaks down the main processes within the system (Figure 3):

- **Sound Detection:** The wearable device detects screaming and triggers the camera.
- **Video Capturing:** Captures the video and sends it to the server.
- **GPS Tracking:** Captures the user's location and sends it to the server.
- **Alert System:** Sends an alert with location and video to emergency contacts and authorities.

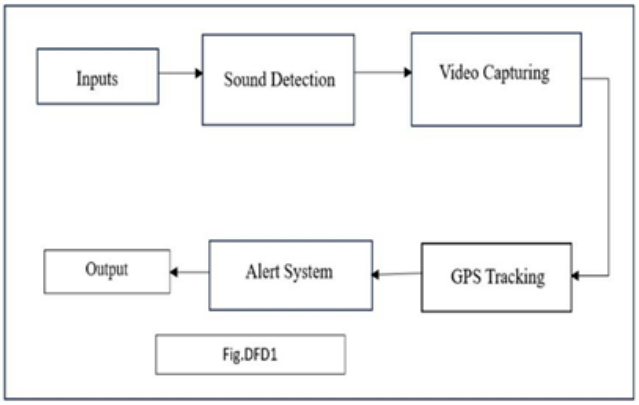

Figure 3 DFD1

2.2.Unit 2: Activity Diagram

- **Start:** User screams.
- **Detect scream:** Device detects scream.
- **Capture video:** Camera captures video.
- **GPS Tracking:** Location is recorded.
- **Send alert:** The system sends an alert with video and location data to emergency contacts.
- **End:** Emergency contacts/authorities receive the alert.

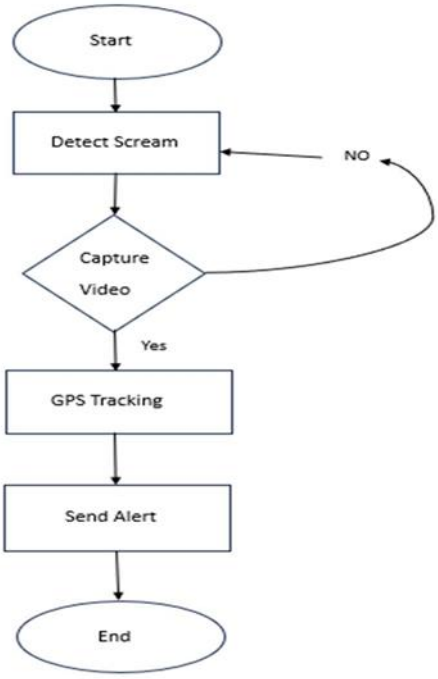

Figure 4 Activity Diagram

2.3.Unit 3: Class Diagram

Shows the different classes in the system and their relationships (Figure 5):

- **Device Class:** Attributes like sound sensor, camera, GPS.
- **Alert Class:** Attributes like video and location.
- **Emergency Contact Class:** Stores emergency contact details.
- **Server Class:** Handles machine learning, alert generation, and data storage.

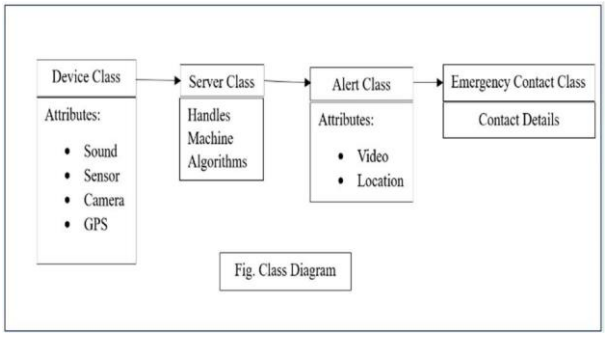

Figure 5 Class Diagram

2.4.Unit 4: Use Case Diagram

Depicts the interaction between the primary user (woman), the device, and emergency

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contacts/authorities (Figure 6).

Actors:

- **User:** Triggers the distress detection.
- **Emergency Contact/Authorities:** Receives the alerts.
- **System (IoT Device):** Detects distress, captures video, and sends alerts.

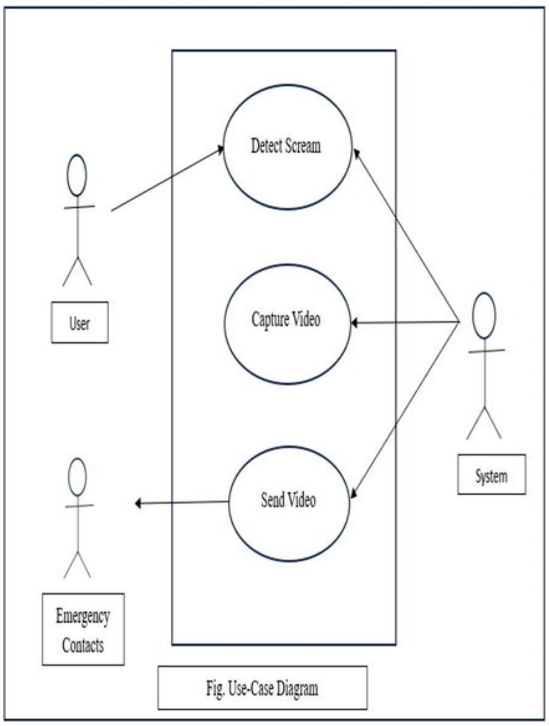

Figure 6 Use Case Diagram

3. Tools and Technology

The women's safety device incorporates a variety of tools and technologies:

- **IoT Connectivity:** Utilizes Internet of Things technology to enable real-time communication between the device and emergency contacts.
- **Machine Learning:** Employs advanced algorithms to analyze sound patterns, allowing it to accurately identify distress signals.
- **GPS Technology:** Integrates GPS for precise location tracking, ensuring quick access to the user's whereabouts during emergencies.
- **Audio Sensors:** Features high-sensitivity microphones to capture distress sounds effectively.
- **Video Recording Module:** Includes a camera component for documenting incidents, which can be crucial for later investigations.
- **Data Encryption:** Implements encryption protocols to protect sensitive information and ensure user privacy.

3.1. Challenges with Current Technologies

IoT-based safety devices for women, equipped with features like video capturing and scream detection, encounter various challenges. One major issue is real-time data processing, which must be swift to ensure an effective response. These devices also need to strike a balance between rapid responsiveness and energy efficiency, as high power consumption can impact their usability. Reliable connectivity is another hurdle, particularly in areas with poor network coverage, as uninterrupted operation is crucial. Protecting user data and securing video/audio recordings from unauthorized access is essential to maintain trust.

3.2. Background Review and Literature Review

The issue of women's safety has garnered significant attention globally, with increasing incidents of harassment and violence reported in both public and private spaces. Traditional safety measures, such as personal alarms and self-defense training, often depend on the victim's immediate action, which can be impractical during a crisis. As technology advances, the integration of IoT (Internet of Things) into personal safety devices presents a promising solution. IoTenabled devices can provide real-time responses and automated alerts, enhancing the ability to protect individuals in distress. This technological shift offers new opportunities for proactive safety measures that are both efficient and user-friendly. Recent studies have highlighted the effectiveness of wearable technology in enhancing personal security. Research indicates that devices equipped with automatic distress detection can significantly reduce response times during emergencies. Machine learning algorithms play a critical role in these devices, allowing for accurate identification of distress signals amidst background noise, thus minimizing false alarms. Moreover, the incorporation of GPS technology ensures precise location tracking, facilitating timely assistance from emergency

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responders. Various prototypes and existing products have demonstrated the potential for video recording features, providing vital evidence in the aftermath of incidents Further exploration into user experience reveals that comfort and ease of use are paramount for widespread adoption. Design considerations that prioritize portability and accessibility can greatly influence the device's effectiveness. Additionally, privacy concerns related to data collection and transmission have been addressed through advanced encryption methods, ensuring that users' sensitive information remains secure. Overall, the intersection of IoT technology and personal safety presents a significant advancement in protecting women's rights and enhancing their security in everyday situations. Continued research and development in this field are essential to refine these technologies and maximize their impact.

4. Applications of Woman Safety Device

- **Women's Personal Safety:** The primary use of the device is to enhance the safety of women, particularly when they are traveling alone or in potentially risky situations. It ensures immediate access to help, providing both reassurance and protection during emergencies.
- **Elderly Care:** This device can be particularly beneficial for elderly individuals who may be at risk of medical emergencies or accidents. It sends instant notifications to family members or caregivers, enabling them to respond quickly and provide necessary assistance.
- **Child Protection:** Parents can rely on this device to monitor the safety of their children, especially in outdoor or unfamiliar settings. The built-in GPS tracking and video capabilities allow for quick location identification or immediate support in critical situations.
- **Workplace Security:** Employees working in high-risk environments or those traveling to unsafe areas for work can use this device to ensure their safety. Employers can track their employees' well-being and guarantee fast intervention in the event of an emergency.
- **Public Safety Workers**: First responders such as police officers, paramedics, or security personnel can use the device to boost their personal safety while on duty. Additionally, it can be integrated into larger security networks to improve community-wide safety and response times.
- **Disaster Relief Operations:** In regions affected by natural disasters or other crises, the device can assist in locating survivors by tracking GPS signals and detecting distress calls, helping rescue teams pinpoint and reach individuals in need of aid more effectively.
- **Health Monitoring:** The device can be equipped with additional sensors to track vital health metrics, such as heart rate or body temperature. This capability could be crucial for early detection of health issues, enabling timely alerts to medical personnel or caregivers.
- **Travel Safety:** Solo travelers, especially in unfamiliar or potentially hazardous locations, can use the device to stay safe. In case of an emergency, the device will send alerts to local authorities or emergency contacts, along with accurate location data, to ensure swift help.

By expanding the device's applications across these varied scenarios, it enhances personal safety and offers an intelligent, automated response in a range of situations where security is a priority.

5. Future Directions and Research Opportunities

- **Advanced Machine Learning for Improved Detection:** While current algorithms can detect distress sounds, future research could focus on enhancing the accuracy of machine learning models. By training these systems with larger and more diverse datasets, they could better differentiate between distress signals and everyday noises, reducing false positives and ensuring more reliable detection in varied environments.
- **Integration with Smart City Infrastructure:** One promising direction is integrating the wearable safety device into smart city systems. This could involve linking the device to urban security networks, such as surveillance cameras, emergency services, and

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smart traffic systems. Real-time alerts could be automatically processed within these infrastructures to facilitate faster, coordinated responses to incidents.

- **AI-Driven Health Monitoring:** Expanding the device's health monitoring capabilities could offer more personalized protection. Future research could focus on integrating advanced sensors that track physiological data (e.g., stress levels, blood pressure, oxygen saturation), helping to predict health emergencies such as panic attacks, heart conditions, or strokes. The device could then alert medical professionals in real time, even before a person's condition becomes critical.
- **Multi-Layered Privacy and Security Protocols:** With increasing concerns over privacy, further research is needed to enhance the device's security framework. This could include exploring advanced encryption methods, secure cloud storage for sensitive data, and decentralized systems that reduce the risk of unauthorized data access. Blockchain technology could also be explored to ensure tamper-proof records of distress signals and responses.
- Battery Life and Energy Efficiency: The development of more energy-efficient components and improved battery technology will be crucial for the long-term functionality of the device. Research into low-power sensors, energy harvesting (e.g., solar-powered systems), or even microenergy technologies could significantly extend the device's battery life, making it more practical for continuous use.
- **Context-Aware Personalization:** Future iterations of the device could include context-aware features that adapt to the wearer's environment. For example, the device could automatically adjust its sensitivity to distress signals based on factors such as the user's location (e.g., urban vs. rural) or activity level (e.g., walking, running). This could improve detection accuracy and reduce unnecessary alerts.
- **Global Scalability and Localization:** For the device to have global applicability, future research should address challenges related to regional variations in emergency response systems, language barriers, and local cultural norms. By localizing features like emergency contact systems, language preferences, and regional laws regarding privacy, the device can be more widely adopted across diverse populations.

Able, and reliable tool that offers comprehensive protection in a wide variety of scenarios. The continued research in these areas will help drive innovation, increase adoption, and ultimately make significant strides toward enhancing personal safety.

Acknowledgement

I would like to express my sincere gratitude to everyone who supported and contributed to the successful development of this project. Special thanks to my mentors and advisors for their insightful guidance and valuable feedback throughout the research process. I am also grateful to my colleagues and friends, whose encouragement and collaboration were essential in refining ideas and overcoming challenges. A heartfelt thank you to the developers and engineers who worked tirelessly on the technical aspects of this device, ensuring its functionality and reliability. Additionally, I appreciate the support from my family, who provided constant motivation and understanding. Finally, I would like to acknowledge the broader research community whose work on IoT technologies and safety solutions inspired this project. Without all of your contributions, this project would not have been possible.

Conclusion

In conclusion, the IoT-based women's safety device offers a promising solution to a growing global concern by providing an automated, hands-free system designed to enhance personal security. The device integrates advanced technologies, including machine learning, GPS, and real-time video capture, to offer an effective and efficient method of distress detection and emergency response. It addresses the limitations of traditional safety measures, offering an immediate and reliable means of support during critical moments. By expanding its applications

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across various scenarios— from personal safety to healthcare, workplace security, and disaster management—the device demonstrates its versatility and potential for widespread impact. Future research and advancements in the areas of machine learning, data security, and user experience will further elevate the device's capabilities, making it a crucial tool in safeguarding individuals in both every day and emergency situations. As technology continues to evolve, this wearable safety device has the potential to play a pivotal role in ensuring safer environments for women and others in need of protection, creating a more secure and responsive world.

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