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A Comprehensive Review Paper on Smart Women Protection System Using IoT

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Abstract: In light of the escalating incidents of violence and harassment against women globally, there is an urgent need for innovative solutions that enhance personal safety. The Smart Women Protection System aims to develop a cutting-edge wearable or portable device that harnesses advanced technology to empower women in unsafe situations. This multifaceted system integrates various self-defence mechanisms including a remotely activated pepper spray, an electroshock module, a high-decibel alarm, and real-time GPS tracking with live streaming capabilities into a single compact device. The system combines hardware components, software algorithms, and open-source technologies to create a holistic safety solution. By enabling women to protect themselves proactively and communicate effectively during emergencies, this project aspires to foster a sense of security, independence, and confidence in women's daily lives.

Keywords: ESP32 Microcontroller, GSM, GPS, Arduino Nano, Wearable Device, Self-Defence.

I. INTRODUCTION

Women face safety concerns in various situations, from public spaces to isolated areas. There is an increasing need for smart devices that can not only alert authorities and loved ones in times of danger but also enable immediate self-defence. This paper presents a Smart Women Protection System that integrates IoT, communication modules, and self-defence tools, providing a compact, user-friendly solution for personal safety.

The Smart Women Protection System seeks to address this pressing issue by developing a multi-functional, portable device specifically designed to enhance women's safety. By integrating various self-defence mechanisms—such as remotely activated pepper spray, an electroshock module, and a high-decibel alarm—this device offers a comprehensive solution that goes beyond mere awareness or deterrence. The incorporation of real-time GPS tracking and live streaming capabilities allows for immediate communication with trusted contacts or authorities, providing a lifeline in emergencies. This dual approach not only equips women with tools for self-defence but also facilitates swift intervention when help is needed.

II. LITERATURE SURVEY

The advancement of wearable safety technology has rapidly evolved over the past decade, driven by the increased concern over personal safety and the ability to leverage IoT for real-time monitoring and alerting. This section delves into the relevant literature that addresses the development and limitations of IoT-based women protection systems, highlighting key technologies such as sensors, communication modules, defence mechanisms, and open-source platforms.

IoT and Wearable Safety Devices

IoT-based devices have gained traction as a solution for real-time monitoring and communication in personal safety systems. Wearable devices equipped with GPS and GSM modules enable location tracking and real-time alerting, which are critical for addressing emergency situations. According to **[1]**, these devices have transformed from basic GPS trackers into sophisticated systems that can detect threats and respond with various safety mechanisms. Studies such as **[2]** have emphasized the role of IoT in expanding the range and efficiency of these devices, allowing real-time data transmission over long distances.

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However, many current systems face limitations in terms of size and functionality. Most devices are either GPS-based, providing only location tracking, or alert-based, offering simple alarms without more complex protective features. The combination of both tracking and defence tools remains underdeveloped in many models. In wearable technology, the challenge is often to strike a balance between the size of the device and the number of functions it can provide without being intrusive to 3the user **[2]**.

Sensor Technology for Threat Detection

Sensor technology plays a crucial role in IoT-enabled women's safety devices. Sensors such as accelerometers, gyroscopes, and heart rate monitors are commonly used to detect abnormal movements or physical threats. In particular, accelerometers and gyroscopes have been widely adopted to detect sudden changes in movement patterns, such as falls or aggressive shaking, which could indicate an assault or emergency. The work of **[3]** underscores the potential of these sensors to reliably monitor user activity, noting that sensor-based data collection is essential for identifying potentially dangerous situations.

The challenge with sensors, as noted by **[4]**, lies in the differentiation between genuine threats and normal activities. False positives are a common problem when these sensors lack advanced filtering algorithms. For instance, routine activities like running or rapid arm movements could trigger false alarms, which diminish the effectiveness of the device. To address this, filtering techniques and threshold-based algorithms have been proposed to ensure that only genuine threats activate the alert system. Still, sensor accuracy and noise filtering remain areas requiring further improvement for more reliable threat detection **[3].**

Self-Defence Mechanisms in Wearable Devices

One of the most innovative aspects of IoT-enabled safety systems is the integration of self-defence mechanisms directly into wearable devices. Research by **[5]** explores the use of pepper spray modules in wearable safety systems. These modules can be activated remotely via sensors or manually by the user, offering immediate protection against potential attackers. The study demonstrated that such mechanisms could be effective in deterring aggressors, especially in close-quarters situations where physical confrontation is imminent.

Another study by **[6]** investigates electroshock modules, which deliver a controlled electric shock to incapacitate an attacker. Electroshock mechanisms have proven effective in several consumer-grade devices like tasers. However, integrating them into a compact wearable device presents challenges, particularly regarding power consumption and the risk of accidental activation. Electroshock devices require a careful balance between safety and effectiveness, ensuring that the user can activate the device easily during an emergency but avoiding unintentional discharge during regular use **[6]**.

In addition to physical defence, many systems incorporate alarm mechanisms. High-decibel buzzers or sirens are commonly included in these devices, as they can attract attention and potentially scare off an assailant. However, as pointed out by **[7]**, the success of these mechanisms often depends on the surrounding environment; in isolated or rural areas, an audible alarm may not be as effective in drawing attention as it would be in a populated area.

Communication and Connectivity Challenges

Real-time communication is the backbone of any personal safety system. Most wearable safety devices rely on GSM or GPRS modules to transmit distress signals, typically in the form of SMS alerts that include GPS coordinates. The study by **[8]** outlines the strengths of GSM-based communication, noting that it allows for wide coverage and is cost-effective for mass adoption. However, GSM networks can experience significant performance degradation in areas with poor signal coverage, such as rural or remote locations. In such cases, the device may fail to transmit the distress signal, leaving the user vulnerable.

Bluetooth and Wi-Fi modules are often used to connect the safety device to a smartphone app, which can provide additional functionalities such as real-time monitoring, manual defence activation, and data tracking. Bluetooth-based systems, as examined by **[9]**, work well for short-range communication, allowing for low-power connectivity to the user's phone. However, the limited range of Bluetooth (usually around 10 meters) restricts its usefulness in situations where the phone is not nearby.

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Additionally, Wi-Fi offers a broader range of communication and can provide cloud-based storage of data, allowing family members or emergency contacts to track the user's status in real time. However, as with GSM, Wi-Fi availability can be inconsistent, especially in rural areas. The reliability of these communication systems is critical, as delays or missed signals could mean the difference between life and death in an emergency.

Open-Source Platforms for Safety Devices

The use of open-source platforms such as Arduino IDE, PlatformIO, and MQTT has significantly reduced the cost and development time for creating personal safety devices. Research by **[9]** highlights the advantages of using open-source systems, particularly their flexibility in programming and their ability to integrate with a wide variety of sensors and communication modules. Open-source platforms allow developers to build highly customized systems tailored to the specific needs of users.

However, the study also discusses the potential security risks associated with open-source technology. Since these platforms are widely available, they can be more vulnerable to hacking and unauthorized access if not properly secured. To mitigate these risks, encryption protocols must be implemented to ensure that communication between the device, smartphone app, and cloud server is secure. Moreover, user authentication mechanisms are necessary to prevent unauthorized individuals from accessing sensitive data or triggering the defence mechanisms remotely **[9].**

III. PROBLEM STATEMENT

There is a growing need for a portable device that not only tracks the user's location but also provides immediate self-defence options in emergencies. Existing solutions are limited to tracking and alerts, which may delay real-time intervention and protection. This project aims to develop an integrated system that ensures quick, automatic activation of safety features when potential danger is detected.

Objectives:

The primary objectives of the Smart Women Protection System project are as follows:

1. Develop a compact, multi-functional safety device tailored for women.
2. Implement real-time GPS tracking for quick emergency intervention.
3. Integrate self-defence tools like pepper spray and electroshock modules.

IV. METHODOLOGY

The proposed Smart Women Protection System incorporates a microcontroller (ESP32 or Arduino) to manage communication between sensors, defence mechanisms, and communication modules. Sensors like accelerometers and gyroscopes detect sudden movements, while a GPS module tracks the user's location in real-time. Self-defence modules, including a remotely triggered pepper spray and electroshock mechanism, are integrated to provide immediate protection. The system uses GSM/GPRS to send alerts to emergency contacts and Bluetooth/Wi-Fi for smartphone connectivity, allowing users to monitor the device and manually activate defence features.

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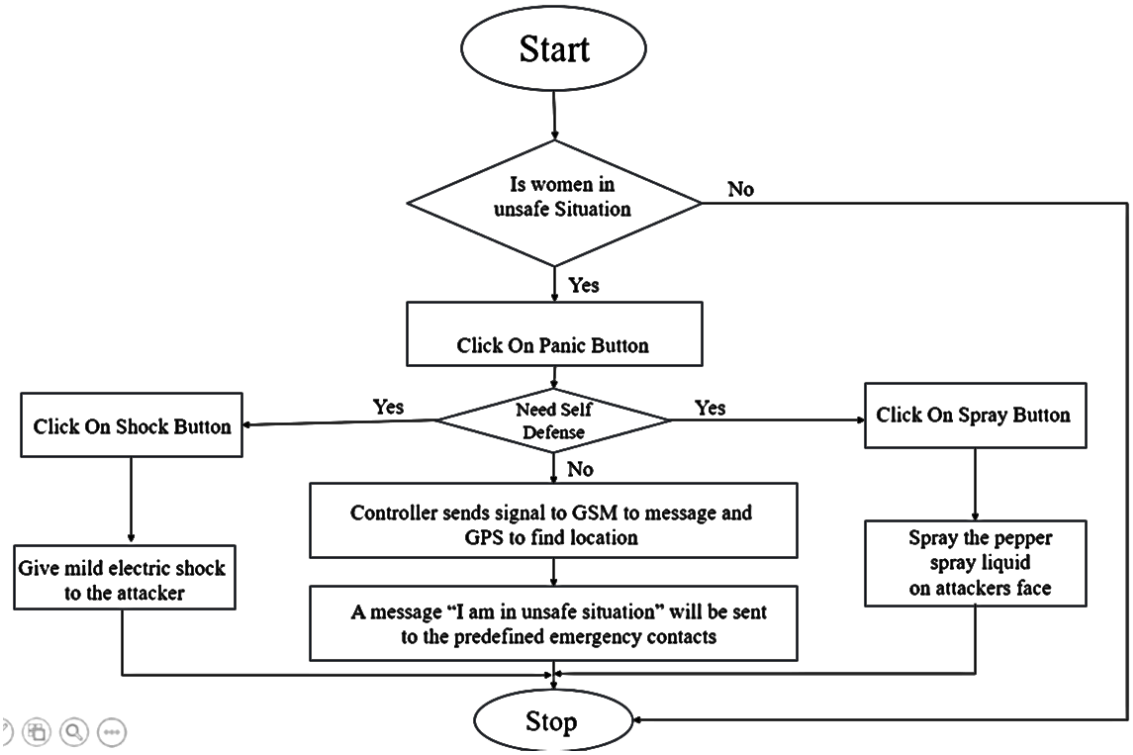
Flowchart:



V. PROPOSED WORK

The Smart Women Protection System aims to overcome the limitations of existing devices by offering a comprehensive, IoT-enabled solution for women's safety. It integrates GPS tracking, self-defence mechanisms (pepper spray and electroshock), and real-time communication with emergency contacts. The system's wearable design ensures ease of use, while its priority-based algorithm ensures that critical actions—such as sending alerts and triggering defence tools—are executed promptly in emergency situations. Additionally, the system's modular design allows for future enhancements, including AI-powered threat detection and customizable defence options.

VI. CONCLUSION

The Smart Women Protection System offers a holistic solution for women's safety by integrating IoT technologies with physical defence mechanisms. This project not only focuses on alerting and tracking but also provides immediate physical intervention tools, making it a valuable solution for personal security. Future developments could focus on further miniaturization and enhancing battery life.

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