Women's Safety Device using IoT

Empowering Women with Smart, Connected Safety Solutions through IoT
Sudeep H U P[1], Prashanth V H[2], Sanketh B M [3], Subramanya S [4], Asst. Professor Prathibha P [5]
Department of Electronics and Communication Engineering Sapthagiri College of Engineering, Bengaluru Visvesvaraya Technological University India

***Abstract*—Women around the world continue to face the serious issue of physical harassment and assault. Ensuring their safety remains a major challenge, as cases of violence and abuse against women and girls are rising every day.**

A self-defense module designed for women's safety, like a smart wearable device, can offer a reliable technological solution. While we may not be able to completely change society overnight, we can certainly use modern advancements to enhance security and protection for women.

Many mobile applications have been developed for women's safety, activated by a tap, click, or shake. However, carrying a phone at all times or accessing it in a moment of crisis may not always be possible. This is where wearable technology can make a real difference.

The "Watch Me" device is designed to provide security to women in situations of danger or harassment. It features a built-in sensor that detects changes in heart rate, which can indicate distress. If a woman wearing this device is exposed to an unsafe situation, the system can immediately trigger an alert for help.

By integrating smart technology into a wearable form, this device offers a practical and proactive solution for women's safety. It serves as a step forward in empowering women and ensuring they have access to immediate support when needed.

I. INTRODUCTION

As per the National Crime Records Bureau, India witnessed an alarming 228,650 rape cases, with Delhi alone reporting 5,234 incidents. In 2011, the Ministry of Home Affairs recorded 24,193 officially reported cases. However, these figures represent only a fraction of the reality, as rape remains severely underreported due to the stigma associated with it.

Statistics reveal a deeply troubling reality—on average, a woman is assaulted every 21 minutes in India, and in Delhi, such incidents occur approximately every 18 hours. This reflects a serious societal failure, rooted in deep-seated gender biases, weak law enforcement, and ineffective legal frameworks. While long-term efforts must focus on addressing these systemic issues, immediate action is crucial.

Recognizing the urgent need for enhanced security, our team has developed the "Women Safety Device," a smart wearable designed to provide real-time protection and assistance. This device is embedded with advanced technology to help women feel safer and more secure in their daily lives.

The "Women Safety Device" is equipped with a dedicated emergency button that, when pressed, immediately alerts nearby police officers. It connects directly to a satellite via GPS, transmitting the user's location through an automated message. Additionally, in emergency situations, the device can generate 60 shockwaves per second as a defense mechanism.

With crimes such as sexual harassment and assault on the rise, the world is becoming increasingly unsafe for women and children. Employed women, in particular, feel vulnerable due to the growing number of incidents. Although various security measures have been introduced, they are often insufficient in preventing such crimes.

II. RELATED WORK

In recent years, research on women's safety solutions has garnered significant attention due to the growing need for reliable and effective technologies. Various studies and initiatives have explored multiple approaches, including wearable devices, mobile applications, and smart security systems, to enhance women's safety and provide immediate assistance in times of distress.

1. Wearable Safety Devices: Many researchers have focused on wearable technologies, such as smart bracelets, pendants, and watches, equipped with GPS and SOS buttons. These devices enable real-time

location tracking and allow users to send distress alerts to preselected contacts or authorities. For instance, some systems incorporate accelerometers to detect abnormal motion patterns, such as falls or struggles, triggering alerts automatically.

2. Mobile Applications: Mobile-based solutions, such as safety apps, provide features like location sharing, emergency contacts, and one-touch SOS alerts. Several apps integrate real-time GPS tracking with audio or video recording capabilities to assist authorities in assessing critical situations.
However, these apps often rely on user activation, which may not always be feasible in emergencies.
3. IoT-based safety systems offer a more advanced and comprehensive approach to enhancing security. Research indicates that integrating wearable devices with IoT platforms significantly improves functionality by enabling automated distress detection, geofencing, and real-time analytics. Environmental sensors, such as proximity detectors, play a crucial role in identifying potential threats, while cloud-based systems ensure secure data storage and seamless communication with emergency services. This integration not only enhances response times but also provides a more reliable and efficient safety network for women.
4. Machine Learning Applications: Studies have demonstrated the potential of machine learning in 27 improving women's safety systems. By analysing historical and real-time data, predictive models can 23 identify patterns associated with threats, enabling proactive measures. This approach enhances the system's reliability and reduces false alarms.
5. Despite technological advancements, current women's safety systems still face several limitations. High false-positive rates often trigger unnecessary alerts, reducing the system's reliability. Many solutions also struggle with scalability, making it difficult to implement them on a large scale. Additionally, most existing devices and applications rely heavily on continuous user interaction, which may not always be feasible in emergency situations. Other key challenges include limited battery life, connectivity issues, and concerns regarding data privacy and security, all of which need to be addressed for more effective and dependable safety solutions.

III. SYSTEM DESIGN AND ARCHITECTURE

The "Enhanced Protection Methods for Women's Safety Using IoT" project aims to provide a comprehensive, technology-driven solution to address women's safety concerns. By integrating wearable devices with IoT technologies, this system ensures real-time protection and enables a rapid emergency response through multiple layers of security. At its core, the system features a smartwatch equipped with advanced functionalities such as GPS tracking for real-time location monitoring, SOS mechanisms that can be triggered manually or automatically, and biometric sensors capable of detecting abnormal physical conditions like increased heart rates or sudden movements, which may indicate distress. Additionally, geofencing technology alerts pre-configured contacts when a user enters or leaves predefined safe zones, while an integrated shock generator provides a self-defense mechanism by temporarily incapacitating an attacker. The ESP32-CAM module enhances security further by enabling live video streaming and image capture, providing valuable evidence when needed.
The system is powered by an ESP32 microcontroller, which ensures smooth communication between all components and facilitates efficient operation. To enhance its reliability and effectiveness, the device is connected to a cloud infrastructure that enables secure data storage and advanced analysis. Machine learning algorithms continuously analyze both historical and real-time data to detect patterns, predict potential threats, and improve the system's responsiveness over time. Furthermore, it is directly integrated with emergency services, allowing real-time location updates, video feeds, and crucial information to be transmitted for swift intervention.
Designed with portability, ease of use, and cost-effectiveness in mind, this IoT-based safety framework is suitable for various environments, including urban areas, workplaces, and remote locations. It supports real-time alerts via SMS, calls, and mobile notifications, ensuring immediate communication during emergencies. Moreover, its scalability allows seamless integration into broader public safety systems. The device combines GPS for location tracking, GSM for distress messaging, an emergency buzzer, and a self-defense shock generator,

providing proactive safety measures and rapid assistance when needed.

By leveraging cutting-edge technology, this project empowers women with intelligent, real-time safety tools that offer immediate protection while also fostering a greater sense of confidence and security. As crimes against women continue to rise, this innovation plays a crucial role in creating safer environments and addressing the urgent need for enhanced personal security solutions.

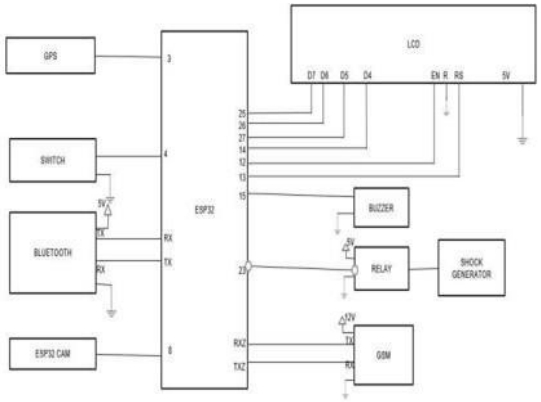

Fig-1: Hardware components

IV. METHODOLOGY

The IoT-based women's safety system is a multifunctional device designed to provide comprehensive protection in emergency situations by integrating advanced technologies. Its core components include a GPS module for real-time tracking, a GSM module for sending alerts via SMS or calls, and a microcontroller that seamlessly manages all functionalities. The system is activated by an emergency button, which immediately transmits location details and distress signals to pre-configured emergency contacts, law enforcement authorities, or nearby responders. Additionally, it features a buzzer to attract attention and a shock generator for non-lethal self-defense.

An integrated ESP32-CAM module enhances security by enabling live video streaming and image capture, allowing victims to document incidents for evidence. Designed for portability and ease of use, the device is available in the form of wearable accessories like smartwatches or pendants, ensuring discreet operation. To enhance its efficiency, the system supports cloud integration, enabling secure data storage, real-time monitoring, and analysis through IoT networks.

A mobile application complements the device by allowing users to configure emergency contacts, view historical data, and access safety recommendations, such as nearby secure zones or escape routes. Future enhancements will incorporate machine learning-based predictive analytics to anticipate potential threats by analyzing user behavior, environmental factors, and historical data. Additionally, 5G integration will enhance connectivity, reduce latency, and ensure faster emergency response times.

The system is designed to address a variety of safety concerns, including travel security, workplace safety, and public space protection, making it a scalable, reliable, and cost-effective solution for women's security in modern environments. A complementary mobile application provides users with features such as geofencing to set safe zones, live location tracking, and real-time alerts. Extensive testing ensures the system's reliability under various conditions, including loss of GPS signal or GSM connectivity. The modular design also allows for adaptability across different use cases, including personal safety, workplace security, and public safety system integration.

By combining cutting-edge technology with a user-friendly approach, this solution ensures scalability, efficiency, and reliability, making it a robust and innovative tool for enhancing women's safety in today's world.

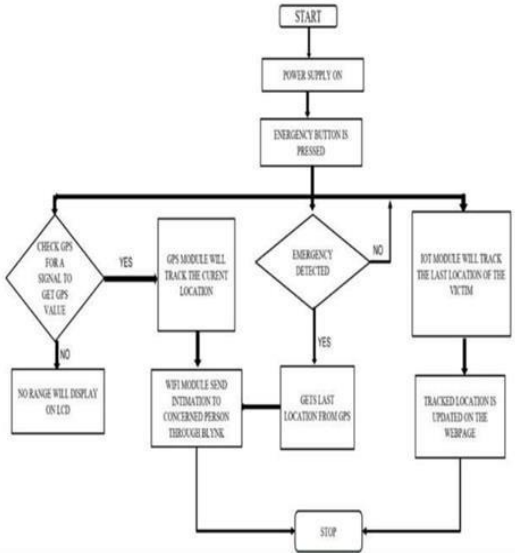

Fig. 2. Flow chart of algorithm

V. FEATURES

Here's a concise summary of the key features you've described:

1. Real-Time Tracking: The device uses GPS technology to continuously monitor and update the user's location, allowing for real-time tracking and ensuring safety through constant awareness of their whereabouts.
2. Emergency Alerts: In case of an emergency, the device automatically sends SMS messages and makes calls to present emergency contacts, notifying them of the user's distress and location.
3. Self-defence: It includes a high-voltage shock generator for self-defence, along with alarm systems, providing an effective way to deter potential threats and alert others in the area.
4. Video Evidence: The device integrates with an ESP32-CAM module to stream live video and capture images, ensuring that there is visual evidence of the situation for later review or as proof of an incident.
5. The device features a wearable, compact, and discreet design, making it convenient for daily use without drawing unnecessary attention. Its lightweight structure ensures ease of carrying, allowing users to integrate it seamlessly into their routine. Additionally, a companion mobile application enhances functionality by enabling users to manage emergency contacts, monitor device status, configure settings, and access tracking data. The app provides a user-friendly interface, ensuring intuitive control and a seamless safety experience.

VI. RESULTS

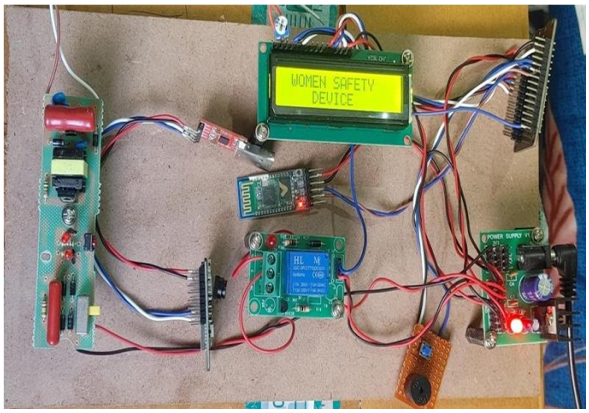

Fig.3. Project model of Women Safety Device

A women's safety device is an embedded system designed to enhance personal security by detecting emergencies and instantly alerting authorities or trusted contacts. It typically incorporates a microcontroller (such as Arduino or ESP32), a GPS module for real-time location tracking, and a GSM module for sending emergency messages or calls. A panic button allows users to manually trigger an alert, while additional sensors, including a pulse sensor, temperature sensor, and accelerometer, can automatically detect distress signals such as abnormal heart rate, body temperature fluctuations, or sudden movements.

Upon activation, the device transmits the user's location details to predefined contacts and may also trigger a buzzer or LED indicator to attract immediate attention. Advanced models incorporate IoT technology, enabling real-time monitoring via a mobile application for seamless communication and safety management. The primary objective of this project is to establish a fast, reliable, and efficient response system, ensuring women's safety in potentially dangerous situations through modern technology.

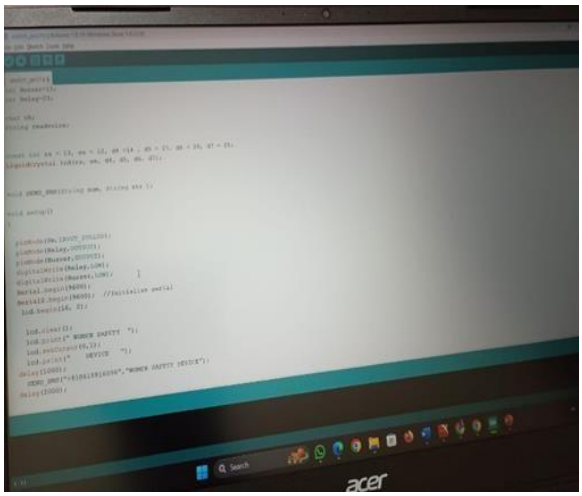

Fig.4. code

Embedded C is an extension of the C programming language, designed to facilitate the development of efficient programs for embedded systems. Although it is not an official part of the standard C language, it is widely used for programming embedded processors and microcontrollers due to its simplicity, efficiency, and hardware-level control.

While C remains the most popular language for embedded system development, assembly language is also used, particularly in scenarios requiring high timing accuracy, optimized code size, or direct hardware manipulation. However, due to its complexity and lack of portability, assembly is typically reserved for performance-critical sections of code.

The Arduino Integrated Development Environment (IDE) provides a user-friendly platform for programming microcontrollers like the Arduino UNO. It supports both Arduino-specific libraries and standard AVR (Advanced Virtual RISC) code, making it possible to write Embedded C programs within the Arduino ecosystem. This flexibility allows developers to leverage pre-built libraries while also writing low-level AVR standard code when necessary for optimized performance.

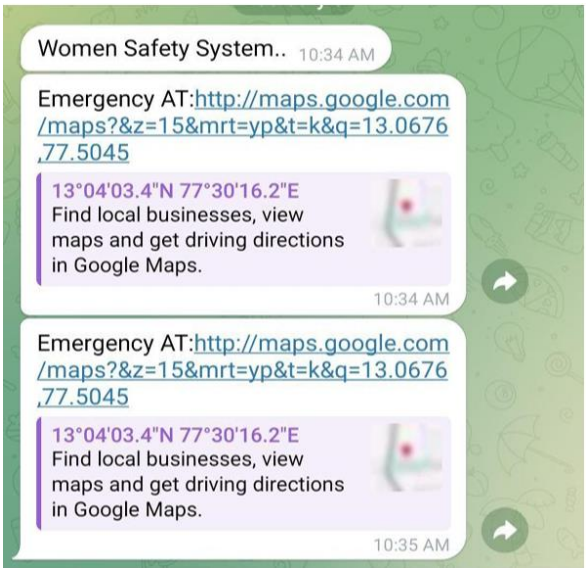

Fig.5. GPS location through link

The image illustrates the distress message sent to predefined emergency contacts when the trigger button or push button of the safety device is activated. The message includes a clear “Emergency” alert, ensuring that recipients immediately recognize the urgency of the situation. Additionally, as shown in Figure 3, the message contains GPS coordinates (latitude and longitude) of the user’s location. This feature enables real-time tracking of the victim, allowing for a swift response in distress situations. By providing accurate location details, the system enhances safety and ensures timely assistance from authorities or trusted contacts.

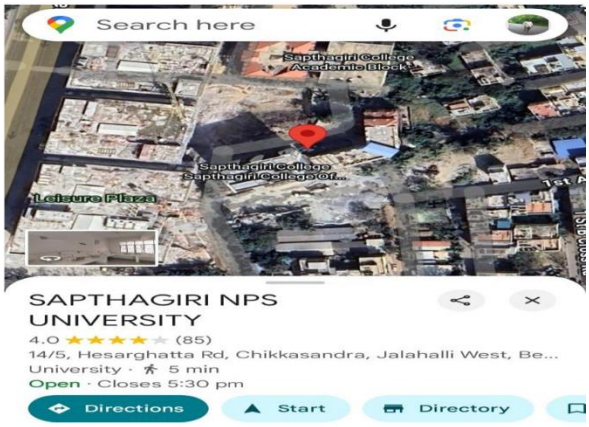

Fig.6. Location of Sapthgiri NPS University

The image depicts the tracked location received by predefined emergency contacts through the distress message. The message includes latitude and longitude coordinates, making it easier to pinpoint the victim's exact location. In case of technical issues or network disruptions, the victim's last recorded location can still be used for tracking. If the situation escalates beyond control, law enforcement can be involved to trace and assist the victim using the same coordinates. This system ensures quick response and enhanced safety, even in critical or unpredictable circumstances.

Fig.7. Video Streamed image

The image showcases the live video streaming feature integrated into the project, made possible through the ESP32-CAM module included in the prototype. This functionality allows video to be streamed on various electronic devices, including mobile phones, laptops, and tablets, simply by accessing the ESP32-CAM’s IP address. The IP address is readily available and can be

looked up online, enabling the victim to use it for real-time monitoring or as evidence against perpetrators. Additionally, this system provides the ability to capture and save images during video streaming, ensuring crucial visual proof in sensitive situations. The recorded footage and stored images can later be used to support legal actions, helping victims seek justice and strengthening the overall effectiveness of the safety device.

Comparison Table

Parameters	C. Priya, et al.,[1]	Proposed Model
Shock Generator	Not included	Included
GPS Accuracy	Less accurate	More accurate

VII. ADVANTAGES

Advantages:

1. Real-Time Tracking and Monitoring: These devices provide real-time location tracking, enabling quick response during emergencies.
2. Enhanced Safety and Security: Features like SOS alerts, geo-fencing, and fall detection ensure that immediate help can be summoned when needed.
3. Compact and Wearable: IoT devices are designed to be small, lightweight, and portable, allowing them to be worn as pendants, bracelets, or clips. Their discreet and ergonomic design ensures ease of use and convenience, making them an ideal safety solution for everyday carry.
4. Immediate Communication: These devices can instantly alert family, friends, or authorities through SMS, calls, or app notifications.
1. Data Analysis and Insights: IoT systems can record and analyze data, offering valuable insights into movement patterns and helping to identify high-risk areas. This data-driven approach enhances predictive safety measures, allowing for proactive interventions and improved security planning.
2. Integration with Smart Devices: They can connect to smartphones and other IoT-enabled systems for seamless communication and control.

VIII. CONCLUSION

This project focuses on designing a comprehensive safety solution for women facing critical situations in today's world. By utilizing compact and wearable technology, such as wristbands and smart spectacles, the system incorporates multiple security mechanisms, including a tear gas release feature and a loud emergency alert with real-time location sharing. This innovation aims to alleviate concerns regarding women's safety by providing a scientific and practical solution to enhance security.

The proposed women's safety device ensures all-around protection by integrating a buzzer to alert nearby individuals in case of an emergency. Additionally, it sends automatic distress messages with the victim's live location to predefined emergency contacts and law enforcement authorities. In situations requiring self-defense, the device includes a shockwave generator to temporarily incapacitate an attacker.

Beyond the hardware-based security measures, the project also features an Android application that enhances safety with additional functionalities, such as sending group alerts, recording audio evidence, and identifying nearby safe locations on a map. This prototype of a smart safety device aims to improve women's security through rigorous performance testing and further refinements to ensure maximum efficiency.

The integration of IoT technologies in this project represents a transformative approach to women's safety, enabling real-time monitoring and rapid emergency responses. Wearable devices, smart sensors, GPS tracking, and AI-powered alert systems work together to provide instant assistance, empowering individuals with proactive protection measures. When combined with community-based initiatives, strong legal frameworks, and increased awareness, such smart solutions have the potential to significantly reduce threats and enhance response times in emergency situations, creating a safer environment for women in both public and private spaces.

IX. FUTURE SCOPE

The future of women's safety devices using IoT holds immense potential, offering enhanced personal security, real-time connectivity, and proactive safety measures. IoT-enabled solutions will seamlessly integrate with smart ecosystems, ensuring instant communication with emergency services, trusted contacts, and community support networks.

Advanced sensors and real-time data analysis will play a crucial role in detecting threats or distress situations, automatically triggering alerts and live location sharing. With the incorporation of AI and machine learning, these systems will evolve to include predictive analytics, identifying potentially unsafe environments and warning users in advance.

Wearable IoT safety devices will become more discreet, efficient, and user-friendly, blending seamlessly into everyday accessories like jewelry, clothing, and smartwatches. Innovations such as extended battery life, energy-efficient components, and solar-powered options will enhance reliability.

Additionally, these technologies will become more affordable and regionally adaptable, ensuring wider accessibility in both urban and rural areas. With continued advancements, IoT-driven safety solutions will play a transformative role in empowering women, reducing risks, and creating a safer world.

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