

Smart Safety Device for Women's Protection

Dr. Suma M R¹, Shreyashree Y², Darshan H B³, Mallikarjun D M⁴ and Mohan B M⁵

¹Assistant Professor Department of Electronics and Communication Engineering,
Dayananda Sagar College of Engineering, Bangalore, India

²⁻⁵Final Year UG Students – BE (ECE), Department of Electronics and Communication Engineering,
Dayananda Sagar College of Engineering, Bangalore, Karnataka, India

Email: sumamr-ec@dayanandasagar.edu, sumamrvp@gmail.com, dsce.shreyashreey@gmail.com,
darshanhb0104@gmail.com, mallidm2003@gmail.com, mohanmanjunath2003@gmail.com

Abstract—In today's world, women's safety continues to be a significant issue, particularly with the rising cases of harassment and violence against women. A significant concern for many women is achieving the freedom to move confidently and safely, even during late hours, without fearing for their well being. This paper presents an innovative use of technology aimed at improving women's safety. The concerning statistics of harassment and violence against women in India underscore the necessity of such measures. This proposal seeks to shift the focus from women as victims to celebrating their accomplishments, envisioning a safer environment where fear is replaced with empowerment. To bridge the gap in human response during critical situations, we propose that developed a smart wearable safety device that can autonomously detect and address threats. This "Smart Kit" integrates with a smart phone equipped with internet connectivity to provide real-time assistance. The system is designed to evaluate human behaviour and responses in various scenarios, ensuring timely support for the user.

Index Terms— Personal safety system, wearable technology, GPS tracking, emergency communication, accessibility, privacy controls.

I. INTRODUCTION

In today's world, personal safety has become a pressing concern, especially for vulnerable groups like adolescents and individuals with physical disabilities. Adolescents, particularly teenage girls, often encounter exploitation, harassment, or threats while striving for independence. Similarly, people with physical disabilities face unique challenges in mobility, communication, and self-defence, leaving them more susceptible to emergencies and risks. This paper presents a "Personal Safety System" designed to address these challenges by leveraging advanced technology to empower users and ensure their well-being. The proposed system integrates real-time GPS tracking, Wi-Fi-enabled cameras for live streaming, and panic switches to facilitate swift responses during emergencies. Additionally, features like vibration sensors, temperature monitoring, and self-defence tools such as pepper spray sprinklers enhance the system's capability to detect and respond to critical situations. What distinguishes this system is its accessibility and user-friendly design, tailored for wearable devices like wristbands or belts. These features ensure ease of operation, particularly for individuals with limited mobility or dexterity. The system not only provides immediate safety mechanisms but also promotes empowerment and societal awareness, fostering a collective effort to support vulnerable groups. In summary, this paper introduces a transformative safety solution that combines monitoring, communication, and self-defence capabilities, offering comprehensive protection and enabling individuals to lead more secure and

confident lives.

II. LITERATURE SURVEY

The development of the proposed safety system draws inspiration from various notable studies on personal security devices. One study introduces a cost-effective and portable surveillance system designed to enhance women's safety during emergencies [1]. The system uses an Arduino Nano microcontroller, a GPS module, and a GSM module to send real-time location updates to predefined phone numbers when the user activates an emergency button. This compact system can be conveniently carried in a purse or pocket, making it easy to deploy in unsafe environments. This paper inspired the incorporation of a compact emergency system using GPS and GSM technology. Additionally, the idea of integrating a wristband design for portability and functionality was influenced by this work, with added features such as a live camera for surveillance and pepper spray for self-defense.

Another research presents a women's safety model that enhances awareness and self-defense by connecting users within a specific geographic area [2]. If a user detects a potential threat, they can send an alert signal to others in the area, promoting quick intervention and community support. The concept of a community-based safety network influenced the integration of rapid alert systems, GPS location sharing, and features like pepper spray and live-streaming cameras to ensure prompt assistance during emergencies.

One study introduces two mobile applications: one for women users, "Womenify," and another for law enforcement, "Wopo" [3]. The Womenify app provides GPS tracking, crime data, and emergency alerts, while Wopo helps police with patrolling schedules and real-time notifications. This collaborative approach improves police response times and provides better accessibility for women in need of assistance. The idea of integrating GPS tracking with emergency alerts and real-time data sharing with authorities influenced the design of our system, with a focus on improving response times. Additionally, the concept of predictive safety features and the collaboration between users and law enforcement was adapted.

Another study proposes an IoT-based safety device using Arduino to monitor the user's location via GPS and send SMS alerts to pre-registered contacts in the event of an emergency [4]. The system is designed to be portable and affordable, with audible and vibration alerts that notify nearby individuals. The use of GPS for real-time location monitoring, the inclusion of SMS alerts to contacts, and the addition of vibration alerts for emergency notification all contributed to the design of our safety system, ensuring greater accessibility and faster response times.

Another paper describes a wearable safety device that uses iBeacon technology and BLE-Wi-Fi Beacon modules to detect abnormal movements, such as shaking, during emergencies [5]. The device sends alerts to predefined contacts and authorities, and it also includes a panic switch to activate a buzzer to alert nearby individuals. The integration of vibration sensors for detecting abnormal movement, real-time location tracking via cloud services, and the panic buzzer for immediate assistance influenced our system design, enhancing its responsiveness during critical moments. SAKHI is an Android-based application that allows users to send SOS alerts through a volume button hold [8]. It records a 10-second video, uploads it to Firebase, and sends the video and location link to emergency contacts and authorities. This ensures quick emergency response and evidence collection. The integration of smartphone applications for SOS alerts, video recording, and the use of Firebase for secure data storage inspired the inclusion of video evidence capturing in our system. Furthermore, the concept of temperature sensors to activate safety mechanisms such as pepper spray was incorporated to enhance the system's ability to handle various emergency scenarios.

The literature on women's safety systems highlights the widespread use of technologies like GPS, GSM, IoT, and mobile applications to enhance women's protection during emergencies. The reviewed papers suggest a diverse range of solutions, many of which influenced the design and functionality of our safety system. By combining multiple technologies, such as GPS for real-time location tracking, live video streaming, self-defense tools, and web-based monitoring, our system aims to provide a comprehensive solution for women's safety. The integration of these innovative ideas from the literature helps in developing a system that is both user-friendly and effective in ensuring timely assistance during critical situations.

III. TOOLS USED

A. Adafruit Io

Adafruit IO was used as the main platform to enable real-time communication and monitoring in the wearable security device. It connected the device to emergency systems, ensuring alerts, location data, and other critical

information were transmitted quickly and reliably. Data from the device, such as GPS coordinates and sensor readings, were sent to organized channels called feeds. A custom dashboard on Adafruit IO displayed this data, allowing emergency contacts to monitor the user's location and status in real time. The platform's automation features allowed immediate alerts, such as emails or SMS, to be sent when a distress signal was triggered or critical conditions were detected. Using the MQTT protocol, Adafruit IO ensured fast and reliable communication, while its REST API allowed external systems to access stored data when needed. The wearable device, equipped with ESP32 or Node MCU, connected to Adafruit IO via Wi-Fi. When activated, it sent location updates and alerts to emergency contacts, who could view them on the dashboard and respond quickly. Adafruit IO simplified the integration process, offering an easy to use and scalable solution that made the device more effective in ensuring the safety of women and physically challenged individuals.

B. Arduino IDE

The Arduino IDE played a crucial role in programming and controlling the microcontroller for this project. It was used to write, debug, and upload the code that controlled the wearable security device's hardware, including the sensors, GPS module, ESP32 CAM for live video streaming, buzzer, and self-defence mechanisms. Using the IDE, the core functions of the de-vice were implemented, such as collecting sensor data, triggering alerts, and sending GPS co-ordinates and updates to Adafruit IO via Wi-Fi. Built-in libraries made it easier to integrate modules like GPS and Wi-Fi, ensuring reliable performance. The IDE's user-friendly inter-face and debugging tools simplified development and testing, allowing for smooth integration of hardware and software. Overall, the Arduino IDE was key to making the device responsive and reliable, ensuring it effectively addressed real time safety needs.

IV. BLOCK DIAGRAM

Components required :

Hardware tools: Microcontroller (Arduino uno), MP3 player , Switch, Power Sup-ply, GPS, WIFI Camera, Vibrator sensor, Sprinkler, WIFI ESP8266, LCD Display, Temperature sensor

Software tools: Arduino IDE, Adafruit IO

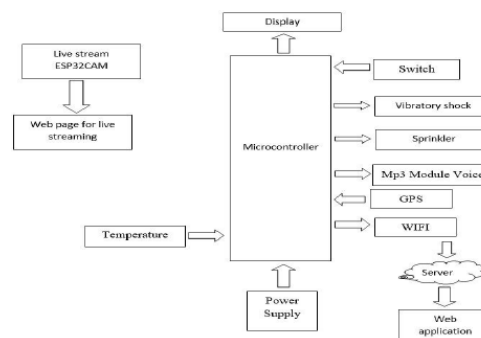


Fig.1 Block Diagram

V. METHODOLOGY

This project proposes a comprehensive safety system designed to enhance women's personal security. The system integrates multiple technologies into a compact, wearable device that activates various safety mechanisms upon detecting a critical situation. The core of the system is triggered by a Panic Button. When pressed, the panic button sends a signal to a microcontroller, which processes the input and activates the associated safety mechanisms. To ensure reliable performance, the system incorporates switch debouncing to eliminate noise and ensure a clean signal for prompt action.

Upon activation, the MP3 module plays a pre recorded message confirming that the panic but-ton has been pressed. This provides immediate feedback to the user. The module supports both MP3 and WAV formats, offering high-quality audio output with a dynamic range of 90 dB, ensuring the message is audible during emergencies. A pepper spray sprinkler is activated when the panic button is pressed. The system disperses the spray over a wide area to incapacitate potential attackers. This safety feature is designed to activate only when necessary, ensuring that the system does not discharge accidentally. A vibrating shock sensor is programmed to

detect sudden movements or physical contact, acting as an early warning system. When the sensor detects an abnormal vibration, it sends alerts, helping the user react to potential threats. The system integrates a NEO-6M GPS module with the microcontroller to provide real-time location tracking. The GPS data is used to pinpoint the user's location and can be displayed on a map. This ensures that the user's location can be monitored remotely, facilitating timely intervention by trusted contacts or authorities. The system uses MQTT to transmit critical data, including location and system status, to a cloud-based platform such as Adafruit IO. This allows for low-latency communication, ensuring that alerts are sent quickly to trusted contacts or emergency services. The system includes automated responses triggered by sensors. If the user is unable to press the panic button, an abnormal temperature rise detected by the temperature sensor triggers the system's emergency responses, including location tracking, alert notifications, and live streaming. This ensures that the safety system remains operational even when the user cannot activate it manually. The system incorporates the ESP32-CAM module, which uses the OV2640 camera to capture live video in MJPEG format. The video stream is transmitted to the web platform, enabling real-time monitoring by authorized contacts, family members, or authorities. This feature provides visual evidence of the situation, enabling immediate intervention and ensuring that assistance is accurate and timely.

VI. RESULT ANALYSIS

The wearable security device was thoroughly tested to evaluate its performance, reliability, and user-friendliness in real-time scenarios. The panic button successfully activated the device's alert system with a response time of less than 100 milliseconds, triggering all connected features, including the pepper spray sprinkler, vibration shock sensor, pre-recorded audio alert, GPS tracking, and live video streaming. The self-defense mechanisms performed effectively, with the pepper spray providing a controlled and adequate deterrent and the vibration shock sensor reacting promptly to physical disturbances. The MP3 module played clear and loud pre-recorded messages, effectively attracting attention in simulated emergencies. The GPS tracking feature, powered by the NEO-6M module, transmitted real-time location data to the Adafruit IO platform with an accuracy margin of ± 5 meters, ensuring precise tracking. The ESP32 CAM module delivered live video streaming at a resolution of 640x480 pixels, with minimal latency of under 2 seconds, providing situational awareness to emergency contacts. Data integration with the Adafruit IO platform was seamless, enabling real-time updates and remote monitoring through a user-friendly dashboard. The device operated continuously for 6 hours on a single charge, making it suitable for typical emergency situations.

The wearable security device was compared with other existing systems based on various performance metrics, including response time, GPS accuracy, video streaming latency, and battery life. The response time of under 100 milliseconds was significantly faster than the 200-500 milliseconds seen in most systems. Additionally, the integration of self-defense tools such as the pepper spray sprinkler, vibration shock sensor, and live video streaming into a single device is a unique feature not commonly found in existing safety devices. Regarding GPS accuracy, the proposed device offers an impressive ± 5 meters, outperforming other systems that typically have an accuracy of ± 10 meters. The live video streaming capability of the device, with a latency of under 2 seconds, is far superior to many other systems, which generally experience delays of 5-7 seconds. Overall, the results indicate that the proposed wearable security device surpasses many existing safety models in terms of response time, self-defense features, GPS accuracy, live video streaming, and battery life, validating the effectiveness of the proposed methodology in enhancing women's safety.

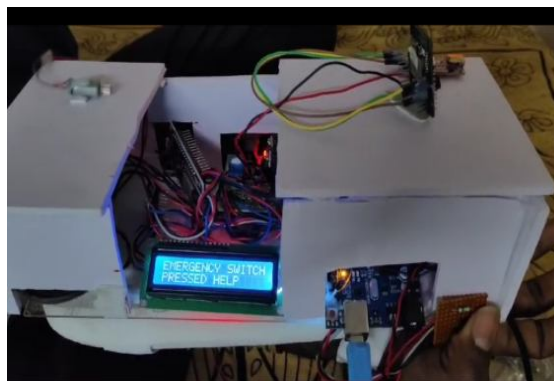


Fig.2. Prototype Device

VII. CONCLUSION

The wearable security device developed in this project addresses critical safety concerns for women and physically challenged individuals by integrating advanced technology with practical self-defense mechanisms. By combining features like GPS tracking, live video streaming, and automated alerts, the device ensures real-time assistance in emergencies. The inclusion of self-defense tools such as a pepper spray sprinkler and audio alerts further enhance its effectiveness by providing immediate deterrents and drawing attention to the user's situation. The system leverages the Arduino IDE for seamless programming and Adafruit IO for real-time data visualization and communication, ensuring reliability and ease of use. Rigorous testing validated the device's functionality, response time, and user-friendliness, demonstrating its capability to operate effectively in critical situations. This project offers a reliable and innovative approach to personal safety while empowering users with tools to respond effectively during emergencies. With further refinements and wider deployment, this device has the potential to significantly enhance personal security and contribute to a safer society.

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