IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

IoT-Enabled Women's Safety Wearable with IP-Based Location Tracking, ESP32-CAM, and Telegram Communication

[1]M R Maanasa, [2]Abhiram L N, [3]Chinmaya M J

[1]Assistant Professor, Department of Electronics and Communication Engineering, Sri Siddhartha Institute of Technology, SSAHE, Tumkur, Karnataka, India

[2,3]Student, Department of Electronics and Communication Engineering, Sri Siddhartha Institute of Technology, SSAHE, Tumkur, Karnataka,India

Doi: https://doi.org/10.56975/ijcrt.v14i7.309967

Abstract: Women's safety has become a major concern due to the increasing number of harassment and emergency incidents occurring in both public and private spaces. Conventional safety systems often suffer from limitations such as delayed communication, dependence on cellular networks, and unreliable location tracking in indoor environments. To address these challenges, this paper presents the design and implementation of the Promise Pendant, a compact wearable safety device developed for rapid emergency response and real-time communication. The proposed system integrates an Arduino Uno, ESP32-CAM module, panic button, voice-assisted activation, and Telegram-based alert mechanism. During emergency situations, the device sends instant alert messages with approximate location details and captured images to predefined contacts through internet connectivity. Initially, GPS and GSM modules were considered; however, due to poor indoor performance, increased hardware complexity, and higher power consumption, the system was redesigned using IP-based location identification and Telegram communication. Experimental evaluation demonstrated that the proposed system achieved reliable emergency alert transmission, reduced response delay, effective indoor operation, and successful hands-free activation through voice commands. The compact design, low hardware cost, and efficient communication make the proposed wearable device suitable for practical women's safety applications.

Index Terms - Women's Safety, Wearable Device, Arduino Uno, ESP32-CAM, Telegram Bot, Emergency Alert System, IP-Based Location Tracking, Voice-Assisted Activation.

I. INTRODUCTION

The IoT-Enabled Women's Safety Device represents a meaningful blend of technology and social responsibility. At its core, the device embodies a pledge — an individual and collective commitment to prioritize the dignity, safety, and empowerment of women. As a wearable solution, it fosters awareness and encourages conversations about respect, equality, and proactive protection.

The proposed system integrates intelligent safety features designed to provide real-time support using embedded sensors, IP-based location tracking, internet connectivity, and Telegram-based communication. The device can share approximate location data with trusted contacts, send emergency alerts, and activate a voice-triggered SOS system during distress. The system is intentionally designed **without AI**

components to keep the hardware simple, affordable, and accessible to a wider population, particularly in rural and semi-urban areas where cost is a significant barrier.

Unlike AI-enabled systems that require complex processing units, machine learning models, and higher power consumption, the proposed IoT-based device achieves reliable emergency response through straightforward trigger mechanisms such as a **panic button and voice keyword detection**. This design philosophy ensures that the device remains **low cost, lightweight, and easy to use** without compromising on the core safety functionality.

It is acknowledged that incorporating Artificial Intelligence could further enhance the device's functionality. AI-based systems can analyze movement patterns, detect unusual situations automatically, recognize distress through voice tone, and provide predictive safety analytics. Features such as fall detection, geofencing alerts, and behavior-based threat detection are possible with AI integration. However, such advancements come with increased hardware cost, higher power requirements, and greater system complexity. **The present work focuses on delivering a practical, budget-friendly wearable safety solution, leaving AI integration as a promising direction for future enhancement.**

Importantly, the IoT-Enabled Women's Safety initiative extends beyond hardware. It represents a broader movement focused on education, advocacy, and community engagement. Workshops on self-defense, digital safety, and situational awareness can complement the product's technological features. Partnerships with schools, universities, workplaces, and local authorities help strengthen support networks and encourage safer public spaces. Awareness campaigns further promote responsible behavior and collective accountability, reinforcing that women's safety is a shared societal duty.

The psychological impact of such a device is equally significant. Knowing that immediate assistance is accessible can reduce anxiety and empower women to navigate daily life with greater confidence. The device symbolizes self-care and self-empowerment, reminding wearers of their strength and the support system surrounding them. Inspired by real-life stories and the need for immediate access to help, the proposed system allows users to quickly send SOS alerts and share their location with trusted contacts. More than just a piece of technology, it represents a commitment to ensuring that no woman feels alone or helpless in a moment of danger — using innovation not just for convenience, but for meaningful and accessible impact.

The proposed work presents an IoT-enabled women's safety system designed to enhance personal security through real-time monitoring and rapid emergency communication. The system incorporates an instant SOS alert mechanism capable of sending emergency notifications and location details to predefined contacts during critical situations. By integrating IoT-based communication with a user-friendly and discreet design, the system ensures quick response, ease of use, and reliable operation — thereby improving safety, accessibility, and emergency communication effectiveness for women at an affordable cost.

II. LITERATURE SURVEY

Recent advancements in wearable safety technologies have focused on developing compact and reliable systems for women’s security using IoT, GPS, GSM, and intelligent communication methods. A smart wearable safety device integrating GPS and GSM modules for real-time location tracking and emergency alert transmission was presented in [1]. The system used a panic button to trigger distress messages containing location coordinates to predefined contacts. The study emphasized compact design, low power consumption, and reliable communication for practical wearable applications.A real-time women’s safety system based on GPS and GSM technologies was proposed in [2], where emergency alerts were transmitted immediately after user activation. The work highlighted the importance of minimizing response delay and improving communication reliability in critical situations. Challenges such as signal availability and battery limitations were also discussed.

An IoT-based smart jewellery system for women’s safety was introduced in [3]. The device enabled discreet emergency communication through wearable accessories such as pendants and bracelets. The system integrated wireless communication technologies to transmit alert messages and real-time location details while maintaining lightweight and user-friendly design characteristics.Object detection and tracking techniques for surveillance applications were extensively reviewed in [4]. The study analyzed motion

segmentation and tracking algorithms for identifying moving objects in real-time systems. The work demonstrated the importance of efficient image processing techniques in improving monitoring and security applications.The integration of artificial intelligence and wearable systems for women's safety was discussed in [5]. The proposed approach utilized sensor data and machine learning algorithms to identify abnormal activities and automatically trigger alerts during emergency situations. The study highlighted improved automation, reduced false alarms, and enhanced threat detection capability.A Bluetooth-enabled smart pendant for women's safety was developed in [6]. The wearable device communicated with a smartphone through Bluetooth connectivity and transmitted emergency alerts when activated. The system focused on low power consumption, compact implementation, and discreet operation, although it depended on smartphone availability and Bluetooth range.An IoT-enabled women's safety band was presented in [7], integrating GPS, GSM, and panic alert mechanisms for real-time monitoring and emergency communication. The system demonstrated reliable alert generation and continuous tracking while maintaining portability and ease of use.

A discreet wearable pendant specifically designed for women's safety was proposed in [8]. The device integrated GPS and GSM modules with a hidden panic button for emergency alert transmission. The study emphasized compactness, user comfort, and simplified activation mechanisms for rapid response during critical situations.A smart wearable safety system using IoT technology was discussed in [9]. The device combined sensor-based monitoring with GPS and GSM communication to provide emergency assistance. The work highlighted the importance of portability, communication reliability, and low-latency response for wearable security systems.

An IoT and machine learning-based women's safety device was introduced in [10]. The system analyzed sensor data to automatically detect abnormal behavior and trigger alerts without requiring manual activation. The study demonstrated the effectiveness of intelligent automation in improving emergency response systems. A compact IoT-based women's safety device with real-time location tracking was proposed in [11]. The system used GPS and GSM technologies to continuously monitor user location and transmit alerts during emergencies. The work focused on communication efficiency, portability, and optimized power consumption for wearable applications.

III. METHODOLOGY

The panic button is a physical input component that enables the user to instantly send a distress signal during emergency situations as shown in Fig.1. When pressed, it triggers the Arduino to execute a predefined sequence of actions, including initiating the location identification process, sending emergency alerts, and activating the visual monitoring system. The button is strategically placed on the pendant in an easily accessible position to ensure quick response, even under stress or panic.

Initially, the system was designed to fetch the user's real-time location using a GPS module. The Arduino would activate the GPS module to obtain latitude and longitude coordinates, which were then included in emergency alert messages. However, during testing, several limitations of GPS were observed. The GPS module requires an open environment with a clear view of the sky to function accurately. In indoor locations, crowded urban areas, or enclosed spaces, the GPS signal acquisition was slow or unreliable. Due to these disadvantages, the GPS module was removed from the system.

To overcome this limitation, the location-tracking mechanism was redesigned using the IP address of the user's mobile device through which the system is connected to the internet. By tracking the approximate location associated with the IP address, the system can determine the user's position without requiring satellite visibility. This approach improved reliability in indoor environments and significantly reduced location acquisition time.

The Arduino Uno serves as the central microcontroller and acts as the brain of the entire system. It is responsible for receiving inputs from the panic button and voice assistant, processing control logic, and coordinating communication between different modules. The Arduino ensures real-time synchronization and seamless execution of emergency protocols.

Initially, a GSM module was used to send SMS alerts to emergency contacts. However, to further reduce hardware size, power consumption, and dependency on cellular networks, the GSM module was replaced with a Telegram bot. The Telegram-based alert system allows instant message delivery, location sharing,

and image transmission over the internet. This replacement significantly reduced the overall device size while improving communication speed and reliability.

The ESP32 camera module enhances system functionality by providing visual evidence during emergencies. When triggered, it captures images or streams real-time video and transmits the data through the Telegram bot. This visual context can be crucial for caregivers or authorities during rescue operations. Finally, the voice assistant feature enables hands-free activation of the system using predefined keywords such as “Help” or “Emergency.” Upon detecting these commands, the system initiates the same emergency response as the panic button, ensuring user safety even when physical interaction is not possible.

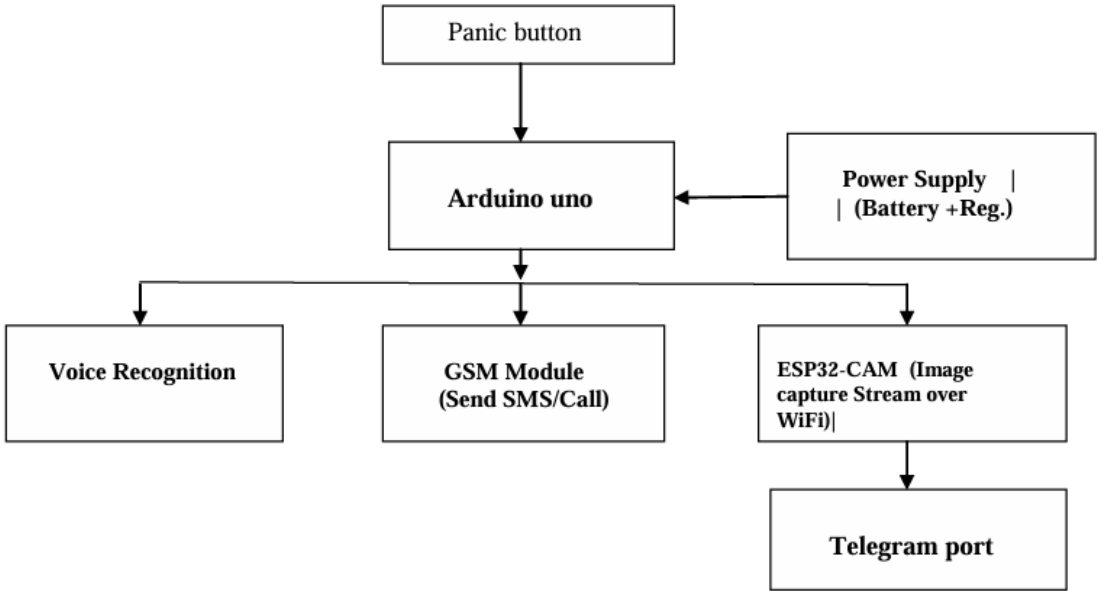
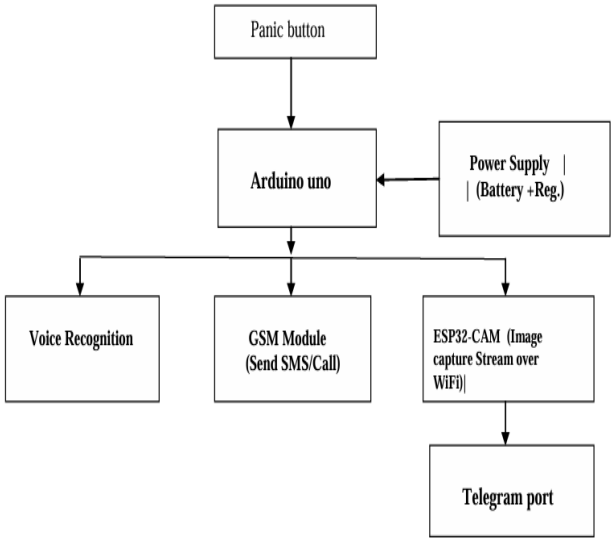


Fig. 1. Block Diagram

IV. RESULTS

The proposed IOT enabled Women’s Safety device in Fig. 2. swas successfully designed and implemented using Arduino Uno, ESP32 camera module, Telegram bot integration, and voice-assisted emergency activation as shown in figure 2. The system was tested under different emergency scenarios to evaluate the response time, communication reliability, and overall operational efficiency The panic button mechanism responded immediately when activated, initiating the emergency protocol within a short duration. The Telegram bot successfully transmitted alert messages along with approximate location details to predefined contacts through internet connectivity. Compared to the earlier GSM-based approach, the Telegram communication method reduced hardware complexity and provided faster message delivery without depending on SMS services.

The IP-based location tracking method demonstrated better performance in indoor and enclosed environments where GPS signals were weak or unavailable. During testing, the system was able to identify approximate user location with reduced delay, making it suitable for real-time emergency applications. Although the location accuracy was slightly lower than GPS in open environments, the proposed method improved reliability in practical usage conditions. The ESP32 camera module effectively captured and transmitted images during emergency situations. The transmitted visual information provided additional situational awareness, which can assist caregivers or authorities during rescue operations. The voice assistant feature also operated successfully by detecting predefined keywords such as “Help” and “Emergency,” enabling hands-free activation when the user was unable to access the panic button physically. Overall, the proposed system achieved reliable emergency alert generation, compact hardware implementation, reduced power consumption, and improved usability. The integration of internet-based communication and voice-triggered activation enhanced the effectiveness of the wearable safety device for women’s security applications.



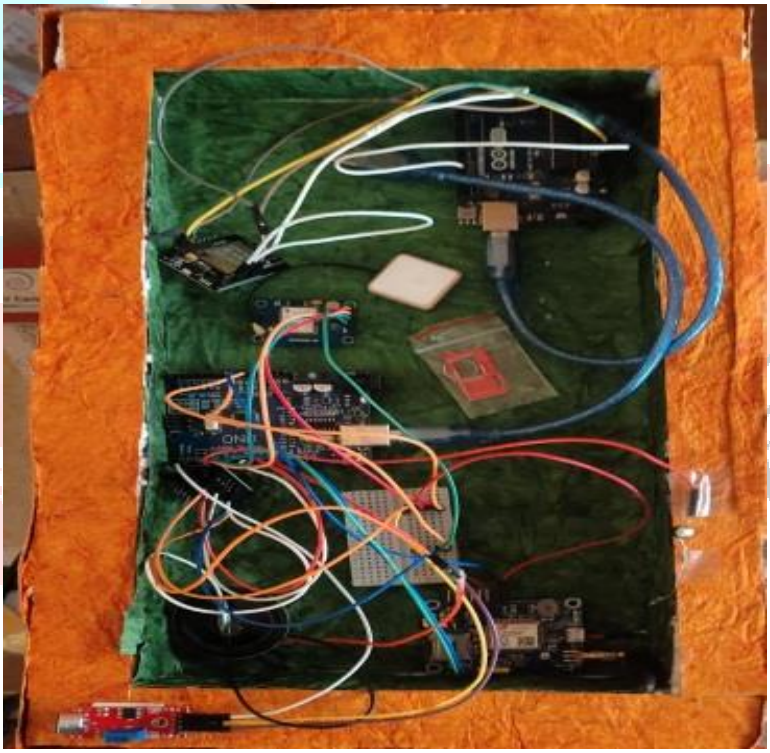


Fig .2.Hardware Setup

V. CONCLUSION

The proposed Promise Pendant system provides an effective and compact wearable solution for enhancing women's safety during emergency situations. The integration of Arduino Uno, ESP32-CAM, Telegram-based communication, panic button activation, and voice-assisted triggering enabled rapid alert generation and reliable emergency response. Replacing the GPS and GSM modules with IP-based location tracking and internet-based messaging reduced hardware complexity, power consumption, and communication delay while improving performance in indoor environments. The system successfully transmitted emergency alerts, location details, and visual information to predefined contacts in real time. The developed prototype demonstrates that smart wearable technologies can provide practical and accessible safety support for women through fast communication, ease of use, and continuous monitoring.

In terms of future scope, several enhancements can be explored to further strengthen the proposed system. **First**, the integration of Artificial Intelligence and machine learning algorithms can enable automatic threat detection based on movement patterns, voice tone analysis, and behavioral anomalies, reducing dependence

on manual activation. **Second**, replacing IP-based location tracking with a hybrid GPS and Wi-Fi positioning system can significantly improve location accuracy in both indoor and outdoor environments. **Third**, the system can be enhanced with a dedicated mobile application that provides real-time tracking, alert history, emergency contact management, and safety analytics for improved user experience. **Fourth**, incorporating biometric sensors such as heart rate monitors and skin conductance sensors can enable automatic stress and panic detection, triggering alerts without any physical input from the user. **Fifth**, the device can be redesigned using more compact and energy-efficient microcontrollers such as ESP32 or Raspberry Pi Zero to further reduce size and extend battery life, making it more suitable for continuous wearable use. **Sixth**, the addition of a two-way communication feature would allow trusted contacts or authorities to respond directly to the distress signal, enabling better coordination during emergencies. **Seventh**, future versions can explore offline emergency alert capability using Bluetooth mesh networking or LoRa communication, ensuring the device remains functional even without internet connectivity. Overall, the proposed system establishes a strong foundation for developing intelligent, affordable, and accessible wearable safety solutions, and the identified future enhancements offer promising directions for advancing women's personal security technology.

REFERENCES

[1] Chandan Gautam, Abhishek Patil, *"Smart Wearable Device for Women's Safety"*, IEEE International Conference, 2022.
[2] P. Das, V. Roy, *"Real-Time Women Safety System using GPS and GSM"*, IEEE International Conference on Emerging Technologies, 2023.
[3] R. Gupta, S. Mehta, *"IoT-Based Smart Jewellery for Women Security"*, IEEE International Conference on Smart Systems and IoT Applications, 2021.
[4] Rupesh Kumar Rout, *"A Survey on Object Detection and Tracking Algorithms"*, Department of Computer Science and Engineering, National Institute of Technology Rourkela, India.
[5] K. Patel, M. Rao, *"AI-Enabled Wearables for Women's Safety: A Review & Alert System"*, IEEE International Conference on Intelligent Systems and Control, 2020.
[6] L. Fernandez, T. Kumar, *"A Bluetooth-Enabled Smart Pendant for Women Safety"*, IEEE International Conference on Communication and Embedded Systems, 2019.
[7] V. Ebenezer, Juvaana Falicicia, *"Design and Implementation of Women Safety Band using IoT"*, IEEE International Conference on IoT and Smart Applications, 2023.
[8] A. Sharma, R. Nair, *"Design and Development of Promise Pendant: A Discreet Wearable for Women Safety"*, IEEE International Conference on Wearable and Ubiquitous Computing, 2021.
[9] S. D. Mohite, P. J. Chavan, *"Smart Wearable System for Women Safety Using IoT"*, IEEE International Conference on Computing, Communication and Automation, 2019.
[10] A. R. Desai, V. P. Kshirsagar, *"Women Safety Device Using IoT and Machine Learning"*, IEEE International Conference on Artificial Intelligence and Smart Systems, 2020.
[11] N. S. Gaikwad, R. R. Patil, *"IoT-Based Women Safety Device with Real-Time Location Tracking"*, IEEE International Conference on Advances in Computing and Communication Engineering, 2018