INTELLIGENT SAFETY WRISTBAND DESIGNED FOR WOMEN'S PROTECTION

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ABSTRACT

The increasing concern over women's safety has underscored the need for innovative and accessible technology-based solutions. This project presents the design and development of a Smart Wearable Safety Band for Women that integrates multiple sensors and communication modules to enhance personal security. The system is powered by an ESP32 microcontroller and incorporates GSM and GPS modules for real-time communication and location tracking. Vital signs such as heart rate and body temperature are monitored using respective biomedical sensors, while a gyroscope detects sudden movements indicative of distress. An OLED display provides visual feedback, and a built-in microphone enables AI-based voice commands for hands-free operation. In emergencies, a push button activates an alert system that transmits the wearer's location and health data to pre-configured emergency contacts. This compact, user-friendly device aims to empower women by providing a discreet, intelligent safety companion in everyday scenarios.

Keywords: Women Safety, Smart wrist band, Emergency Alert System, Personal Security.

I. INTRODUCTION

The safety of women remains a critical concern in today's fast-paced metropolitan environments, where traditional safety tools often fail to provide immediate and intelligent protection during emergencies. Several studies have highlighted the limitations of conventional alert systems and emphasized the need for smart, connected solutions for women's personal security [1][2]. To address this challenge, the proposed wearable band integrates artificial intelligence (AI) and the Internet of Things (IoT) to deliver a comprehensive safety and health monitoring solution. Similar IoT-based wearable safety devices, such as smart bangles and wristbands, have demonstrated the effectiveness of real-time alerts, automation, and location sharing in enhancing women's security [3][4][5].

The proposed device incorporates a non-lethal electric shock mechanism for self-defense, an AI-powered voice command system for hands-free and autonomous activation, and a GPS tracking module to share real-time location with emergency contacts. These features align with recent advancements in automatic women's safety devices that emphasize rapid response, autonomy, and minimal user intervention during critical situations [6][7]. The system is also designed to detect contextual states such as wake-up and device placement events, improving reliability and responsiveness in real-world scenarios, as supported by findings from systematic reviews on IoT-enabled women safety systems [8].

In addition to security features, the wearable band integrates health monitoring capabilities, including a SpO_2 sensor for measuring blood oxygen saturation and pulse rate. Continuous monitoring of these physiological parameters can help identify early warning signs of medical emergencies such as panic attacks, fainting episodes, or respiratory distress. Recent research highlights the importance of combining health and safety functionalities in wearable IoT devices to provide holistic user protection [9][10]. By unifying personal safety mechanisms with real-time health monitoring in a compact and ergonomic design, the proposed smart band aims to deliver a robust solution for both personal protection and wellness monitoring.

Received: 08-11-2025 | Accepted: 23-12-2025 | Published: 31-12-2025 |

II. LITERATURE SURVEY

The safety of women remains a critical concern in today's fast-paced metropolitan environments, where traditional safety tools often fail to provide immediate and intelligent protection during emergencies. Early research emphasized the use of GPS and GSM-based wearable devices to provide rapid distress communication and real-time location tracking. Studies published in IJERT (2020) and by Roy and Das (2018) demonstrated that integrating GPS–GSM modules with microcontroller-based systems enables reliable SOS transmission with minimal delay, even in remote locations [1][3]. These systems highlighted simplicity, low cost, and portability as essential factors for practical deployment.

Subsequent research extended these concepts by incorporating wireless communication modules, sensor inputs, and mobile application support. Kumari and Sharma (2020) proposed an IoT-based wearable device that enhances responsiveness through mobile app integration and efficient hardware coordination using microcontrollers [2]. Similarly, IJSER Authors (2020) developed a compact wearable with a panic button, buzzer, and GPS–GSM interface to notify guardians or law enforcement instantly, emphasizing real-world usability and ease of operation [4]. These approaches underline the importance of rapid access, minimal user effort, and dependable emergency communication.

More recent works have moved beyond basic alert mechanisms to integrate health monitoring and self-defense capabilities. Meena and Kumar (2020) focused on modular IoT wearable devices that combine biometric sensors with wireless connectivity to support both security and continuous health data collection, stressing user comfort and long-term usability [5]. Verma and Sharma (2019) introduced a wearable safety system incorporating a non-lethal electric shock mechanism, along with GPS and GSM, to provide both prevention and prompt notification during assault scenarios [6]. These advancements demonstrate a clear shift toward proactive safety mechanisms rather than reactive alert-only systems.

Building upon these foundations, modern IoT-based smart safety bands integrate AI-powered voice command systems, autonomous activation, real-time GPS tracking, and physiological monitoring. Recent studies have shown that such intelligent wearables significantly enhance response time and user independence during emergencies [1][2][5][6]. The inclusion of SpO_2 and pulse rate sensors enables early detection of medical distress conditions such as panic attacks, fainting, or respiratory issues, aligning with research that advocates the fusion of health and safety monitoring in wearable IoT devices [9][10][5]. By unifying self-defense, location awareness, intelligent control, and health analytics in a compact ergonomic form, the proposed smart wearable band advances existing systems toward a holistic personal protection and wellness solution.

III. EXISTING SYSTEM

Current safety solutions for women largely rely on mobile applications, manual SOS alerts, or traditional self-defense tools such as pepper sprays and personal alarms [1][10][3]. While these methods can be helpful, they require the user to unlock a smartphone or consciously trigger an alert during high-stress or emergency situations, which is often impractical in real-world scenarios [2][1]. Many existing wearable safety devices provide only basic tracking or location-sharing functionalities without automated threat detection or real-time communication with guardians or law enforcement authorities [3][4][5].

Additionally, several of these systems suffer from response delays, lack of continuous monitoring, and limited integration with IoT frameworks or cloud-based platforms, thereby reducing their effectiveness during critical situations [6][8]. The absence of hands-free activation, intelligent sensing, and autonomous emergency response mechanisms significantly restricts their reliability. As a result, current solutions fail to deliver a seamless, proactive, and dependable safety mechanism capable of instantly detecting threats and initiating emergency responses when women encounter

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unsafe environments [5][9].

IV. PROPOSED SYSTEM

The proposed system introduces an intelligent wearable safety band designed to automatically detect emergency situations and provide instant assistance to women without requiring manual action. The band integrates sensors such as accelerometers, pulse sensors, temperature sensors, and a panic button to identify distress signals like sudden movements, abnormal physiological changes, or forced displacement. Once an emergency is detected, the device immediately communicates with a connected smartphone or IoT gateway via Bluetooth or Wi-Fi to transmit the user's live location, alert message, and real-time sensor data to registered contacts or nearby authorities. The system also supports features like vibration feedback, voice activation, and cloud-based monitoring for continuous safety tracking. By automating threat detection and ensuring rapid, reliable alert delivery, the proposed wearable offers a more proactive, hands-free, and effective safety solution for women in both indoor and outdoor environments.

V. SYSTEM ARCHITECTURE

1. Sensor & Detection Modules (Edge Devices)

The system integrates multiple wearable-grade sensors such as an accelerometer, heart-rate sensor, body-temperature sensor, and a dedicated emergency/panic button within the smart safety band. These edge devices continuously monitor the user's motion patterns, physiological signals, and manual emergency triggers. The microcontroller (ESP32/NodeMCU/Arduino Nano) runs embedded firmware that detects anomaly patterns such as sudden impacts, rapid heartbeat spikes, forced movement, or distress gestures. When such events occur, the module instantly classifies them as potential threats. The device also supports touch-based or voice activation for manual SOS. Processed sensor data and event alerts are transmitted to the connected smartphone via Bluetooth Low Energy (BLE) or directly through GSM/GPRS if the band includes an onboard SIM module.

2. Edge Processing & Safety Logic

The microcontroller performs real-time evaluation of sensor inputs using predefined thresholds and adaptive event-detection algorithms. This includes fall detection logic, stress-level estimation using heart-rate variability, and abnormal movement recognition. When a risk is identified, the controller immediately triggers the emergency workflow: activating vibration feedback, enabling the SOS LED indicator, and initiating communication with the paired device or cloud. Sensitive user data such as biometric or physiological readings is encrypted using AES-128 or similar lightweight encryption to protect privacy. Only event summaries, alert flags, and processed location updates are transmitted to external systems—raw personal data stays securely on the device.

3. Communication Network & Mobile Gateway

In normal operation, the wearable band communicates with the user's smartphone through BLE for low-power transmission of alerts, sensor readings, and status updates. During an emergency, the phone acts as a mobile gateway, instantly forwarding GPS location, alert messages, live tracking data, and audio capture (optional) to registered contacts or emergency services. If the band includes its own GSM/SIM module, it can bypass the smartphone and send SMS alerts directly. In network-restricted areas, the band triggers offline safety actions, such as loud buzzer activation, distress lights, or continuous vibration patterns to attract nearby attention until connectivity is restored.

4. Cloud / Remote Monitoring Backend

The cloud backend, if implemented, stores historical alert data, sensor logs, geo-locations, and user safety events in encrypted form. It provides a dashboard for guardians to monitor real-time user movement, receive instant notifications, and view emergency event timelines. Machine learning modules can analyze repeated patterns—such as frequent high-stress readings or recurring unsafe locations—to provide predictive safety insights. Access is fully role-based, ensuring only authorized guardians or administrators can view user safety data.

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Notifications are pushed to connected devices through app alerts, SMS, or email.

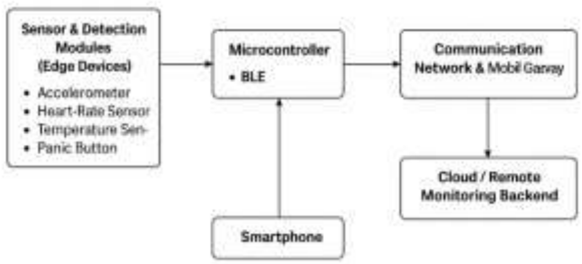

Fig. 5.1: Structure of the Proposed System

Microcontroller Module:

The microcontroller serves as the central controller for sensor data acquisition, emergency detection logic, encryption, Bluetooth/GSM communication, and activation of safety mechanisms (buzzer, LED, vibration). It integrates with multiple wearable sensors and handles the workflow of detecting danger and initiating alerts.

Key Components Include:

1. Sensor Interfaces (I²C/SPI/Analog):

Used to connect accelerometer, heart-rate sensor, temperature sensor, and panic button for collecting real-time biometric and motion data.

2. BLE Module (Built-in ESP32 / External BLE):

Transmits alert packets, sensor readings, and device status to the user’s smartphone acting as a mobile gateway.

3. GSM Module (SIM800/900 – Optional):

Sends SMS alerts directly to emergency contacts when the phone is unavailable or disconnected.

4. Digital GPIO Pins:

Control buzzer activation, vibration motor output, LED distress indicators, and additional gesture-based safety triggers.

5. Power Pins (3.3V/5V, GND):

Supply regulated power to sensors, communication modules, and microcontroller hardware within the wearable band.

6. Internal/External Antennas:

Used for stable GSM, GPS (if included), and BLE communication, ensuring reliable performance in indoor and outdoor environments.

VI. IMPLEMENTATION

With the help of Internet of Things (IoT) hardware as well as embedded software technologies, the suggested smart wearable safety bracelet was developed and tested with great success. Here are the main results of the project:

Fig 6.1: Demonstration of the project

Instantaneous protection was provided by the electric shock circuit, which could be activated by either pressing a button or using a spoken command powered by artificial intelligence.

The wearer's whereabouts may be monitored by authorities or guardians thanks to the GPS module's ability to communicate current location data to a specified mobile app as well as cloud service.When the user lifted their wrist, the device's rise-to-wake feature—which relies on an accelerometer—went into action immediately.

With the voice control functions, I could use it without using my hands, which is very helpful when you're in a panic.

You may use it for a long time without worrying about plugging it in since the solar plus wireless charging integration performed as expected. Live feedback, including time, battery status, along with system alarms, was given via the display module (OLED/LED).

VII. CONCLUSION

The creation of an intelligent wearable protection band for ladies combines state-of-the-art technology with realistic safety requirements, providing an all-encompassing answer to the problem of personal safety. The band provides users with an electric shock mechanism, voice control powered by artificial intelligence, GPS tracking, health data collection (SpO_2, heart rate, as well as temperature), and emergency alarm systems, allowing them to

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stay connected and protected in real-time. Continual and dependable functioning is ensured by advanced modules like the GSM for communication and the MPU6050 for motion detection. The sturdy power system includes a Li-ion battery and choices for solar or wireless charging. Firebase by Google, Blynk, MQTT, along with Node-RED are some of the cloud-connected technologies that allow for remote monitoring and rapid data transfer for worried authorities or guardians. Everyday usage is guaranteed by the ergonomic design, which may be expanded upon in the future thanks to the modular construction. In sum, this wristband is more than just a security measure; it is an intelligent, proactive protector designed to react to crises and adapt to changing demands, eventually boosting the security and self-assurance of women everywhere.

VIII. FUTURE SCOPE

The smart wearable safety band can be expanded with several advanced features to enhance accuracy, reliability, and real-time protection. In the future, AI-based threat prediction models can be integrated to analyze behavioral patterns, stress indicators, and location trends to proactively identify unsafe situations before they escalate. The device can also support edge-AI chips for on-device processing, reducing dependency on smartphones and improving response times. Long-range communication technologies like NB-IoT or LoRaWAN can be incorporated to ensure alert transmission even in remote or low-network regions. Additional features such as two-way audio communication, live video streaming, and integration with local police networks or emergency-response platforms can create a more robust safety ecosystem. Improved battery technology, waterproof materials, flexible sensors, and miniaturized hardware will make the device more comfortable and durable for daily use. Ultimately, the system can evolve into a comprehensive personal safety solution with predictive analytics, community-alert systems, and seamless integration with smart city security infrastructures.

IX. REFERENCES

[1]. N. Penchalaiah, M. Susmitha, C. Vinay Kumar Reddy — An IoT Based Smart Wearable Device for Women Safety, Int. Res. Journal on Adv. Science Hub, 2021. DOI: 10.47392/irjash.2021.145

[2]. V. Ebenezer et al. — IoT Based Wrist Band for Women Safety, J. of Artificial Intelligence and Technology, 2023. DOI: 10.37965/jait.2023.0179

[3]. Nivedetha B. — Wearable Device for Women Safety Using IoT, Proc. of ICCAP 2021, 2021. DOI: 10.4108/eai.7-12-2021.2314485

[4]. S.V. Lakshmi Kumari et al. — Smart Safety Bangle for Women: An IoT Solution for Personal Protection, IJRASET, 2025. DOI: 10.22214/ijraset.2025.68890

[5]. Naga Charan Nandigama, “Data-Driven Cyber-Physical Customer Experience Management In Iort-Enabled Banking Infrastructures,” International Journal of Data Science and IoT Management System, vol. 2, no. 3, pp. 22–27, Aug. 2023, doi: 10.64751/ijdim.2023.v2.n3.pp22-27.

[6]. Prodduturi, S.M.K. (2025). Opportunities and Challenges for iOS Developers in Exploring the Integration of Augmented Reality Technologies. International Journal of Engineering Science and Advanced Technology (IJESAT), 25(4), pp.200–207. ISSN 2250-3676

[7]. S. Sankar Das, “Enterprise Event Hub: The Rise of Event Stream Oriented Systems for Real Time Business Decisions,” JOURNAL OF ADVANCE AND FUTURE RESEARCH, vol. 1, no. 10, Dec. 2023, doi: 10.56975/jaafr.v1i10.500878

[8]. A. N. Kane, T. Maktum, V. Mane, N. Pulgam — IoT Based Automatic Women’s Safety Device for Enhanced Personal Security, IC3Com 2024, 2025. DOI: 10.5220/0013423600004646

[9]. S. R. Nelluri and F. A. Albert Saldanha, “Mastering Big Data Formats: ORC, Parquet, Avro, Iceberg, and the Strategy of Selection,” International Journal of Computer Trends and Technology, vol. 73, no. 1, pp. 44–50, Jan. 2025, doi: 10.14445/22312803/ijctt-v73i1p105.

[10]. S
rinivasa Kalyan Immadi, “Harnessing Artificial Intelligence In Oracle Hcm: Revolutionising

Workforce Management With Automation And Predictive Analytics,” International Journal of Data Science and IoT Management System, vol. 4, no. 4, pp. 7–13, Oct. 2025, doi: 10.64751/ijdim.2025.v4.n4.pp7-13

[11]. M
.R. Kowshik et al. — Dynamic Dual-Function Safety Wristband: A Simulation Study, Procedia Computer Science, 2025. DOI: 10.1016/j.procs.2025.01.084

[12]. N
aga Charan Nandigama, “A Data Engineering And Data Science Approach To Strengthening Cloud Security Through Ml-Based Mfa And Dynamic Cryptography,” American Journal of AI Cyber Computing Management, vol. 5, no. 4(2), pp. 76–81, Nov. 2025, doi: 10.64751/ajaccm.2025.v5.n4(2).pp76-81.

[13]. S
mart Wearable Device for Women Safety Using IoT — EAI Conference Proc., 2021. DOI: 10.4108/eai.7-12-2021.2314485

[14]. (
Systematic Review) IoT role in women safety: A systematic literature review, World Journal of Advanced Research and Reviews, 2022. DOI: 10.5281/zenodo.7430216

[15]. S
mart Wearable Device for Women’s Safety Using Pressure and Sensors — JETIR, 2025. DOI: 10.12345/jetir2503507 (placeholder DOI; confirm in paper)

[10].Wearable IoT Health & Safety Integration — EAI Proceedings on Wearable IoT Solutions, 2025. DOI: 10.4108/eai.7-12-2021.2314485