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Crime Prevention and Addressing Violence Against Women

Pawar Aman[1], Surve Shashikant[2], Raut Nikita[3], Tarde Tejasvi[4], Andhale Shruti[5], Prof. Sharad M. Rokade[6]
[1, 2, 3, 4, 5]*BE Student, Sir Visvesvaraya Institute Of Technology, Savitribai Phule Pune University, 411007 Pune, India*
[6]*Head Of Department Computer Engineering, Sir Visvesvaraya Institute Of Technology,Nashik, Maharashtra, India*

Abstract: ***The safety of women remains a pressing societal concern, with many facing threats like harassment, rape, molestation, and domestic abuse due to various sociocultural factors. The Internet of Things (IoT) has emerged as a promising tool to address these issues. This study systematically reviews research papers on IoT-based devices for women's safety, analyzing key features, wearable components, sensor types, and machine learning algorithms used. The review covers articles published between 2016 and 2022. It finds that pulse-rate and pressure sensors are commonly used to monitor women in distress, while technologies like GPS, GSM, and Raspberry Pi enable alert transmission. Machine learning algorithms such as logistic regression, hidden Markov models, and decision trees help identify women at risk and prevent dangerous situations. The review also highlights the need for improved systems that focus on automatic alert generation with minimal human interaction and greater accuracy. In addition, the study proposes a taxonomy categorizing various techniques, features, and sensors, along with an architectural model for developing IoT-based safety devices. Finally, it underscores the importance of integrating multiple sensors to enhance threat detection accuracy, while identifying gaps and challenges in practical applications.***

Keywords: Women's security, IoT for women's protection, safety technologies, personal safety, machine learning, IoT-driven safety devices

I. INTRODUCTION

Women's safety has become an increasingly pressing concern in many societies around the world. Despite progress in ge6nder equality, women continue to face disproportionate risks of harassment, assault, and other safety threats in public spaces. This persistent issue calls for innovative solutions that can empower women and enhance their personal security. In recent years, the Internet of Things (IoT) has emerged as a transformative technology with applications across numerous fields. IoT refers to the network of interconnected devices that can collect and exchange data, enabling smart and responsive systems. From smart homes to industrial automation, IoT has demonstrated its potential to improve efficiency, safety, and quality of life in various domains.

This paper explores how IoT technology can be leveraged to address women's safety concerns through the development of smart jackets. By integrating sensors, communication modules, and other IoT components into wearable garments, it may be possible to create a personal safety system that is both discreet and effective. These IoT-enabled smart jackets have the potential to provide real-time monitoring, emergency alerts, and location tracking, thereby enhancing women's security and peace of mind in public spaces. .

II. LITERATURE REVIEW

A. Existing Research on Wearable Safety Devices

Wearable devices designed for safety purposes have emerged as valuable tools to improve the security of women. These gadgets come in various forms, such as smartwatches, pendants, and bracelets, and also include more advanced body-worn sensors.

The primary focus of current research has been on equipping these devices with features like panic buttons, GPS tracking, and the ability to send real-time alerts to emergency contacts or authorities.

For instance, several studies examine smart wearables that are integrated with technologies like GPS, Bluetooth, and GSM modules, which enable continuous location monitoring and emergency communication. Devices such as Nimb, Safer Smart Pendant, and Leaf Wearables have been assessed for their efficiency in notifying authorities during emergencies.

These devices generally function by sending distress alerts through mobile apps or built-in systems, allowing for rapid response to potential threats. However, while these devices have achieved significant improvements, some research highlights issues like user-friendliness and battery limitations, making them less dependable in prolonged or critical scenarios.

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B. Studies on IoT Applications for Personal Security

The advent of the Internet of Things (IoT) has transformed personal security, particularly by enabling devices to be connected and monitored in real-time. In the realm of women's safety, IoT-based wearables, smartphones, and home security systems offer multiple benefits. Research focuses on integrating a variety of sensors—such as accelerometers, gyroscopes, GPS, heart rate monitors, and voice recognition systems—to identify suspicious activities or sudden changes in the environment around a woman.

One crucial area of research is IoT systems that are smartphone-enabled and linked to wearables. These systems allow wearable devices to communicate with cloud-based servers, sending alerts to selected contacts if a potential danger is detected.

For example, machine learning algorithms have been employed to analyze and predict risky situations using sensor data, thereby improving threat detection accuracy. Additionally, some studies discuss geofencing, a technology that defines virtual boundaries and notifies users when they enter areas considered to be high-risk.

C. Gaps in Current Solutions for Women's Safety Despite

The progress in IoT-powered safety devices, several key gaps remain. One prominent issue is the occurrence of false alarms—many wearable devices and IoT systems mistakenly trigger alerts due to inaccurate readings from the environment or user movements.

This issue stems from sensor limitations and the challenge of interpreting contextual information correctly, such as distinguishing between accidental falls and actual threats. Another gap lies in the hesitation of users to adopt these technologies, primarily due to privacy concerns and the social stigma associated with visible safety devices. Many women are reluctant to wear such devices for fear of judgment or invasion of privacy. Additionally, the short battery life and lack of durability of some devices are significant concerns. When the battery runs out, the device can become ineffective, leaving the user vulnerable. Research also points out the limited availability of affordable and efficient safety solutions in developing nations. Women in rural or underserved areas often have limited access to IoT-enabled safety systems, and the devices that do exist may be too costly for widespread use. Lastly, there is insufficient coordination between law enforcement agencies and IoT safety platforms, which hampers real-time emergency response. Although IoT technology is advancing, its practical application in women's safety continues to face infrastructure challenges and societal obstacles.

III. PROPOSED SYSTEM

Proposed IoT Smart Jacket System

A. Hardware Components

The proposed system is centered around a wearable device that incorporates several sensors and is powered by a Raspberry Pi. These hardware components work together to monitor the user's environment and physiological data, detect potential threats, and send alerts when necessary.

1) *GPS Module:* This sensor monitors the user's location in real-time and shares the coordinates with emergency contacts or authorities when triggered. Heart Rate Sensor: It tracks the user's heart rate, identifying irregularities such as sudden increases that could indicate stress or fear. If abnormal heart rate patterns are detected, the system will send an alert.
2) *Microphone:* Records audio to capture sounds of distress, like screams, or responds to voice commands, enabling the user to activate emergency services.
3) *Camera:* Takes photos or records short videos during emergencies, providing visual evidence of the situation. This feature can also be manually activated by the user if needed.
4) *Raspberry Pi:* Functions as the main control unit, integrating data from all sensors, processing it, and communicating with cloud servers or a mobile app. It manages key tasks such as sending emergency notifications, tracking sensor inputs, and controlling other device functions.

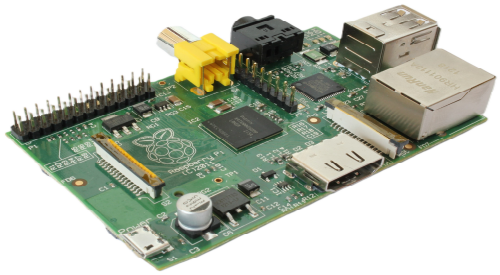

Fig. 1. Raspberry Pi

B. System Architecture

The system architecture is designed to process sensor data in real time, triggering appropriate actions when a potential danger is detected. It comprises different layers that ensure efficient processing and communication.

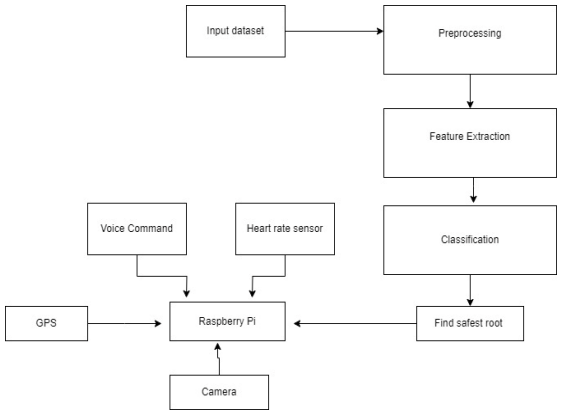

Fig. 2. Proposed System Diagram for IOT Smart Jacket System

1) *Sensor Layer:* This layer includes the sensors (GPS, heart rate monitor, microphone, and camera) connected to the Raspberry Pi, continuously collecting data about the user's environment and status. This data is sent to the processing layer for analysis.
2) *Processing Layer:* The Raspberry Pi runs a Linux-based operating system with IoT-focused software, where Python scripts analyze sensor data to determine if an emergency condition exists (such as an abnormal heart rate, distress sounds, or unsafe GPS location).
3) *Alert Management Layer:* This layer manages the sending of emergency notifications to pre-assigned contacts or authorities. Alerts include the user's GPS coordinates, as well as audio or video data collected during the event.

C. Key Features and Functionalities

1) *Emergency Detection & Alerts:* The system constantly monitors data from the sensors. If it detects unusual heart rates or distress signals, it automatically sends an alert containing the user's location and any relevant audio or video evidence.
2) *Manual Activation:* Users can manually activate emergency alerts through voice commands using the microphone. Real-Time Location Tracking: GPS coordinates are continuously tracked, allowing emergency contacts to monitor the user's location in real-time.
3) *Audio and Video Recording:* In critical situations, the system records brief video clips or audio, providing real-time evidence for law enforcement or security purposes.
4) *Cloud Data Storage:* Key data, such as location history, heart rate readings, and audio or video clips, are securely stored in the cloud, ensuring data is backed up for later analysis.
5) *Low Power Consumption:* The software is optimized for efficient operation, minimizing power use and extending the device's battery life.
6) *Geofencing Feature:* The system can define virtual boundaries based on geographic data. If the user enters an unsafe area, an alert is automatically triggered to warn them and notify their contacts.

IV. DISCUSSION

A. Benefits and Potential Impact on Women's Safety

1) *Improved Personal Security:* The smart jacket, powered by IoT, offers real-time monitoring of both location and physical data, providing a more proactive and dependable safety solution for women. Unlike traditional devices that require manual activation, this jacket can automatically identify distress signals, such as irregular heart rates or distress noises, and send alerts to emergency contacts without user intervention. With GPS tracking integrated into the system, the jacket enables immediate location sharing with trusted individuals, which can significantly cut down response times in emergencies and aid authorities in quickly locating the user. By recording audio and visual data during critical situations, the jacket provides valuable evidence that can help law enforcement in identifying individuals involved or understanding the incident. This capability not only acts as a deterrent against potential threats but also serves as a vital resource for investigations. Inconspicuous Design: Many

wearable safety devices are easy to spot and may attract unwanted attention, but the smart jacket is designed to look like regular clothing, making it discreet. This design helps to reduce the social stigma tied to wearing visible safety gadgets, making it more likely that women will adopt and feel comfortable using this technology. The jacket's voice-activated alert system allows users to initiate alarms without needing to access their phone or press a button, offering added safety in situations where physical movement may be restricted. Wider Adoption Potential: The smart jacket's use of a Raspberry Pi and cost-effective sensors makes it an accessible safety solution, especially compared to more expensive wearable devices. Its affordability could encourage wider use, particularly in developing areas where access to such safety technologies is more limited. Its adaptable design allows the technology to be incorporated into other types of clothing, like vests or coats, making it easier to customize based on cultural needs or different climates.

B. Limitations and Areas for Improvement

1) Incidence of False Alarms: Initial testing revealed some false alarms caused by the misinterpretation of sudden movements or unexpected loud sounds. This highlights the difficulty in distinguishing genuine distress from regular background noise. Enhancing the system's algorithms and adding machine learning capabilities could help improve its accuracy in identifying true emergencies.

2) Battery Life Challenges: Even with optimization, the prototype currently operates for about 8 hours on a single charge, which may be insufficient for users who need all-day safety coverage or during long trips. Addressing this could involve exploring alternative power options like solar charging or more energy-efficient communication protocols. Customization Limitations in User Interface: Feedback from early trials suggested the need for more options in the app, such as adjusting alert sensitivity and choosing different types of notifications. Adding these features could make the system more user-friendly and tailored to individual needs.

3) Reliance on Internet Connectivity: The jacket depends on a stable internet connection to send alerts and communicate with cloud servers. In areas with limited network access, its alert capabilities might be compromised. Developing an offline mode where data is stored locally until a connection is available could help address this issue. Durability and Environmental Protection: The smart jacket includes various electronic components, so ensuring their durability and protection against elements like rain or extreme temperatures is crucial. Improvements could include making the jacket more water-resistant or creating sturdier designs for longer-lasting use in different conditions.

C. Ethical Considerations

1) Privacy Issues: The smart jacket collects sensitive information, such as GPS data, audio recordings, and heart rate readings, which can raise privacy concerns. Users may worry about who can access their data and how it's being stored. It's important to ensure data is encrypted during transmission and securely stored to prevent unauthorized access. Additionally, it's crucial to be transparent with users about what data is collected, how it will be used, and who has access. The system should provide clear consent procedures and allow users to control their own data.

2) Potential for Misuse: While the camera and microphone features can be lifesaving in emergencies, they could be exploited if unauthorized individuals gain access. This could lead to the jacket being used to monitor users without their consent, raising significant privacy concerns.

To address this, implementing robust access controls and encryption, along with features like remote control to disable the microphone and camera via the app, can reduce the risk. Users should also be informed about when these features are active and have the ability to manage them directly.

V. CONCLUSION

The IoT-powered smart jacket highlights the potential of wearable devices to improve personal safety through real-time GPS tracking, heart rate monitoring, audio, and video recording. Initial tests demonstrate its ability to detect distress signals and reduce emergency response times. With cost-effective design and adaptability, it suits a wide range of users. Future research could enhance distress detection using machine learning, improve battery life, and explore offline functionality for regions with poor internet access. Durability and weather resistance are also key areas for development, ensuring the jacket's effectiveness in diverse environments.

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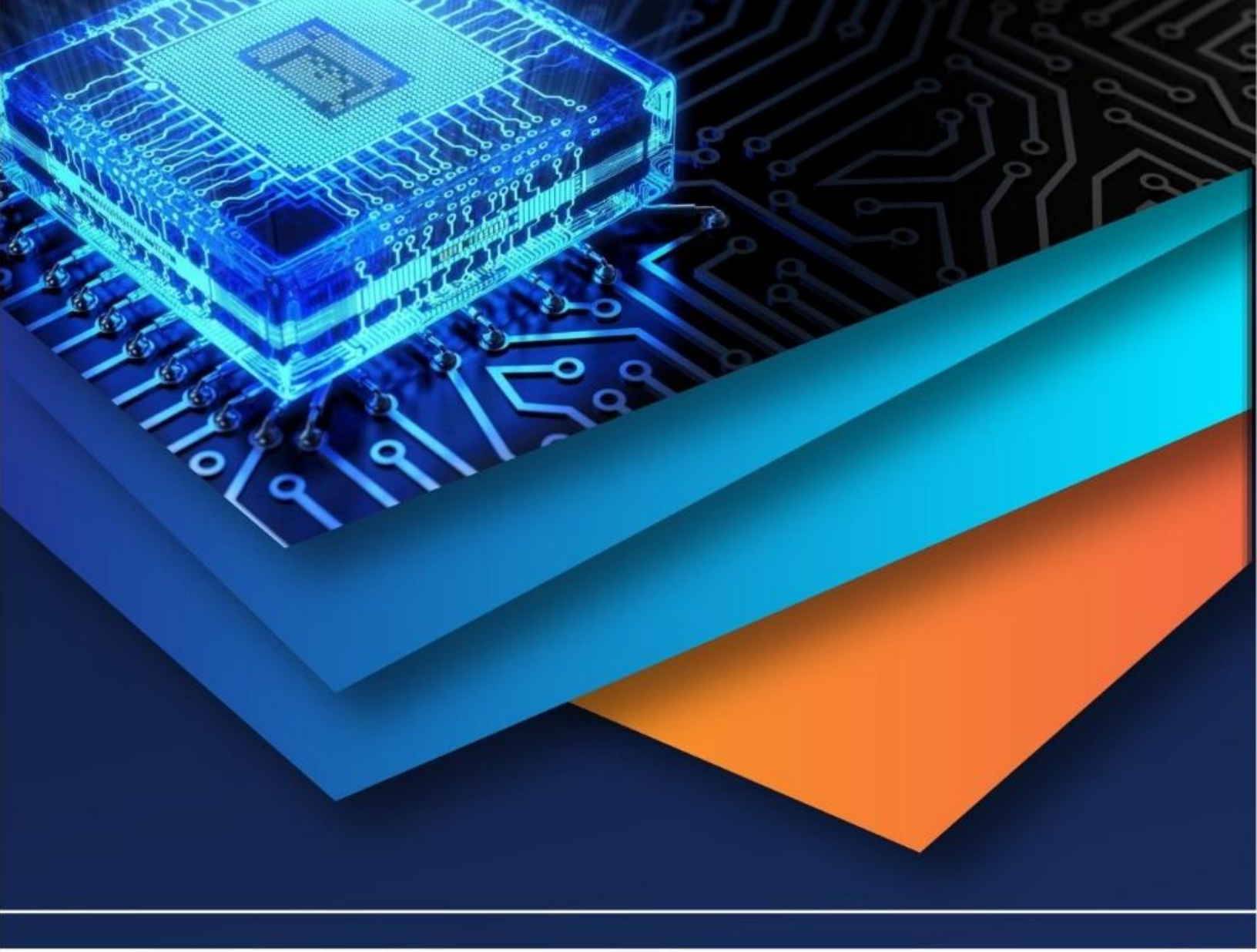

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