

Rakshika: A Systematic Review of Artificial Intelligence and Internet of Things Solutions for Women's Safety

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Abstract: The increasing global awareness of gender-based violence and harassment has led to the emergence of innovative technologies focused on improving women's safety. This review paper looks at the evolution, design, and societal impact of various safety devices and solutions tailored to empower women in diverse environments. These technologies incorporate wearables, mobile applications, and stand-alone devices with advanced GPS tracking and emergency alert system capabilities in place to facilitate response in high-risk situations within real time. Emerging technologies of the IoT, AI, and ML have transformed and are evolving these solutions that allow predictive analytics, intelligent detection, and proactive responses. It includes critical challenges such as privacy,

security of data, accessibility for underprivileged groups, and the requirement of more inclusive and intuitive designs along with technological advancements. Other issues that it also presents include usability validation and how the adoption of these devices may be promoted by governments and organizations. This paper, through the analysis of key innovations and their real-world applications, demonstrates how technology can empower women and make public and private spaces safer, thus contributing to gender equality and societal progress.

Keywords: Artificial intelligence, Convolutional neural network, Crowd monitoring, GPS tracking, IoT (Internet of Things), Wearables, Women security.

I. INTRODUCTION

The safety of women has become a global concern, especially with the rising cases of harassment, assault, and violence against them. Whether at home or in public, women face constant threats that endanger both their physical and mental well-being. The 2012 Nirbhaya case deeply shocked the nation and triggered widespread protests, calling for stricter laws, safer environments, and swifter justice for women in India.

This led to a series of legislative reforms throughout the country, including the Criminal Law (Amendment) Act of 2013 [1]. However, despite these changes, women in India continue to face the threat of sexual violence. Alarming cases like the gang rape and murder of a Dalit woman in Hathras, India, in 2020. This case not only threw a beam of light on systemic failures in how such crimes are dealt with but also cast very wide-ranging questions on justice and law enforcement accountability as well as on issues of caste-based violence [2]. Another one is the most recent brutal rape and murder of a young, promising and ambitious doctor within the premises of the RG Kar Medical College in Kolkata has sent shockwaves throughout the medical community and the whole country concerns about the safety of women, even in spaces where they should feel secure [3]. These cases reflect a global issue that transcends geographical and cultural boundaries, necessitating immediate action through both social reforms and technological solutions and highlight that the problem of women's safety is far from resolved.

Despite government efforts and legal frameworks designed to reduce such violence, the reality is that women remain vulnerable to harassment and assault in everyday situations. There is a clear need for practical, real-time solutions that can protect women and enable rapid responses during dangerous situations. Women's safety devices have become indispensable in combating gender-based violence. These tools range from basic personal alarms to advanced wearables and mobile apps with features like GPS tracking, emergency alerts, and real-time monitoring, offering quick assistance when needed most.

This review paper examines the development and effectiveness of these devices, focusing on their design, functionality, and practical use, especially in response to rising incidents. It also explores how technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML) can enhance personal safety. The paper emphasizes how technology empowers women, creating safer environments both publicly and privately.

In addition, it addresses challenges like privacy concerns, accessibility, and user adoption, while identifying opportunities for innovation to further improve women's safety. The paper will assess available technologies, highlight key innovations, and evaluate their ability to reduce risks in vulnerable situations. It will also explore the difficulties these devices face, such as privacy issues, limited access, and inconsistent adoption rates. Finally, the paper will consider future directions for advancing women's safety technology, with a focus on AI, ML, and IoT to create more personalized and predictive solutions.

Even though no panacea will likely completely eliminate the risk of sexual violence, a perfect combination of legal reforms, change in attitude from society, and technology-based safety measures will definitely reduce the levels at which women have to suffer. It is all about creating an atmosphere where women feel safe enough and are empowered to walk freely in public places, at home, or online.

II. LITERATURE SURVEY

A literature survey is a critical component of research that involves reviewing and synthesizing existing scholarly work on a particular topic. A literature survey provides a strong foundation for the research being conducted, allowing the researcher to build upon existing knowledge and demonstrate their familiarity with the field.

The issue of women's safety in India has been at the top of societal concern and academic research for some time now, especially with major cases of sexual violence surfacing. The 2012 Nirbhaya case - in which a young woman was brutalized, gang raped, and murdered in Delhi - marked a turning point and

sparked widespread protests for tighter laws, safer environments, and swifter justice. Public outbursts even spurred some legislation: such as the Criminal Law Amendment Act 2013, aimed to harden the laws against sexual crimes. Still, sexual assault remains a significant issue facing Indian women [1].

The gang rape and murder of a Dalit woman in Hathras in 2020 exposed not only systemic failures in handling such crimes but also underscored issues of caste-based violence and raised serious questions about justice, law enforcement accountability, and systemic bias [2]. More recently, the brutal rape and killing of a young doctor in the premises of RG Kar Medical College in Kolkata shocked the medical community and raised alarms about women's safety within spaces presumed to be safe. These incidents underscore the urgent need for robust safety measures and comprehensive reforms to ensure the safety and dignity of women in both public and private domains [3].

The existing literature on women's safety technologies highlights the development of mobile applications and wearable devices designed to improve personal security. Several mobile apps and wearable equipped with SOS features and GPS tracking have proven effective in assisting women in distress. Research has shown a notable decrease in response times and high user satisfaction with these applications [4]. For example, systems that employ sensors and data processing to alert authorities have proven effective in protecting women during emergencies. These systems can be seamlessly integrated into live surveillance setups for ongoing monitoring. In the future, we can expect the Internet of Things (IoT) technologies to broaden their applications to fields like healthcare and military operations [5].

One particular system uses GPS tracking to find victims and sends security alerts to nearby police stations, as well as notifications to pre-saved contacts via a GSM module. It also features a buzzer system with a sound range of 80-110 dB, which can be heard from up to 50 feet away [6]. An emergency application built with Dc-RFO-IoT technology aids women by providing essential critical thinking tools in crisis situations. When the emergency button is pressed,

notifications are dispatched to registered contacts, women's helpline, and authorities, complete with GPS coordinates to pinpoint the victim's location [7].

Additionally, ongoing research in AI-driven wearable technology aims to identify potential attackers in public areas, using advanced deep learning models like Mirasys VMS to spot women who may be in distress or at risk [8]. Other systems utilize hardware components like Raspberry Pi, GPS, GSM, and force sensors to detect threats. These devices send real-time location data to authorities or emergency contacts [9]. However, while some of these systems provide significant protection, they are often costly and impractical for everyday use. Research continues into making these solutions more affordable and accessible to all women [10].

Created an AI-integrated safety band that predicts hazardous situations based on user trends, and learns above insights with time [11]. A smart surveillance system that included real time video analytics AI and IoT to observe surroundings and automatically identify potential safety hazards was introduced [12]. Investigated the use of artificial intelligence to find advanced digital forensics to protect women's online presence and deter cyber bullying by raising alerts in advance as well as providing protective measures [13].

Leveraging mobile apps that offer self-defense lesson and SOS services, enabling women to enjoy physical and cyber security tools at any given time [14]. Provided a summary of mobile applications that improve safety using GPS based location tracking and SOS systems to avert cases of violence between individuals [15]. In the course of the project EmpowerHer, we have created a guardian wrist band which has vibrating alerts for the unsafe zone in addition to the panic button for emergency alerts through the mobile application [16].

Launched a women's safety gadget for real-time tracking and location sharing, aimed at preventing sexual violence and introducing the GPS-GSM capabilities in it [17]. Conducted an assessment of the SAATHI device, an Internet of Things enabled adaptive safety system which enables ongoing supervision and mechanical notification to the trusted

contacts in case of detection of any threat or unusual behavior [18].

A wore panic button and Internet of Things based monitoring systems review was conducted which emphasizes the real time response capabilities found in the systems [19]. Analyzed mobile applications designed to assist victims of domestic violence in self-prevention along with their features such as anonymity, geo-tracking and integration of emergency contacts for high-risk women [20]. Presented a concept where real time health monitoring combined with health environmental detection is used to activate alarms. The idea is based on the internet of things wearable devices for women's safety [21]. Investigated the contribution of artificial intelligence and the internet of things in delivering predictive analysis in identifying dangerous scenarios for women and sending alerts to authorities or emergency contacts [22].

AI language models like BERT, GPT-3, and RoBERTa can enhance women's safety by enabling

real-time threat detection, sentiment analysis, and natural language understanding in safety apps [23]. Palm recognition offers a secure, biometric method to authenticate and access safety devices. It ensures that only authorized users can activate emergency features, such as panic alarms or real-time location sharing, and provides discreet, seamless activation of safety protocols in high-risk situations, safeguarding both personal data and physical security [24]. Face recognition technology using Convolutional Neural Network can be used to automatically identify and track people in real-time. This helps monitor public spaces and detect known threats, sending alerts if a woman is near someone suspicious or in an unsafe area, improving safety and awareness [25-27]. Detecting diabetic retinopathy early allows for proactive monitoring of women's health. By scanning the retina for initial signs, it facilitates timely medical intervention and helps lower health risks [28, 29].

Table I shows the comparison of different techniques used for women's safety.

TABLE I: COMPARISON OF INNOVATIVE SOLUTIONS FOR WOMEN'S SAFETY

Sr. No.	Publishing Year	Paper Title	Author Name	Technology
[1]	2024	Ensuring Women's Safety using Wearable Technology (AI and IoT): AI Tools and Applications for Women's Safety.	Manjula, Devarakonda Venkata, Madhu Palli, and Tejasri Boddu	<i>Techniques:</i> YOLOv6, a deep learning algorithm, deep learning model Mirasys VMS. <i>Features:</i> SOS button acts as an instant lifeline, Safe-Guard's voice-activated assistance, Ability to capture both audio and video.
[2]	2024	Transforming Women Safety with Information Technology: A Mobile Real-Time Intelligence Framework.	P. Gupta, K. Singh, and B. K. Sidhu	Introduces a mobile framework for real-time intelligence, including GPS tracking, emergency alert systems, and incident reporting. Uses mobile devices to ensure the safety of women in real-time, based on real-time monitoring.
[3]	2024	V-Safe-Anywhere: Empowering Women's Safety with Wearable AI and IoT Technology.	V. R. Bora, and B. Nagpure	Focuses on wearable AI and IoT technologies for women's safety, featuring location tracking, real-time alerts, and geo-fencing. The system aims to ensure safety through real-time data collection and analysis.
[4]	2024	Empowering Safety: Designing of an IoT-Based Women Protective System using Artificial Intelligence-enabled Smart Sensors.	R. Sonia, T. R. Kumar, G. Naresh, S. D. Devi, and N. Juliet	Proposes a system combining IoT and AI-based smart sensors for real time monitoring and alerting, focusing on wearable devices. Uses AI for activity and movement detection and provides real-time notifications.

Sr. No.	Publishing Year	Paper Title	Author Name	Technology
[5]	2023	Automatic Prediction and Identification of Smart Women Safety Wearable Device using Dc- RFO-IoT.	K. Srinivas Rao, D. V. Divakara Rao, I. Patel, K. Saikumar, and D. Vijendra Babu	<i>Techniques:</i> MLSTF categorization concept based on emotive elements. <i>Sensors:</i> Body Position. Identification Sensor, Accidents Recognition Sensor, GPS sensor. <i>IoT Components:</i> IoT Wi-Fi Module with ESP8266 inbuilt Microcontroller, OLED Display, Emergency Button, Pin Hole Camera with Mic, Relay Unit, Alert Buzzer.
[6]	2023	Maximizing Women's Safety with an Effective System.	B. Amruta, and Mohammed Taheer	<i>Protocols Used:</i> Short Message Peer to Peer Protocol (SMPP), Wireless Application Protocol (WAP), Geofencing API.
[7]	2023	IoT Based Smart Wearable Device for Women Safety.	Sunita Malaj	<i>IoT Components:</i> EPS32 SOC, UBLOX NEO6M GPS Modem, push button, OV2460 Camera Module, OLED Display, Buzzer, LIPO Battery.
[8]	2023	Android-Based Woman Safety App.	P. Sarma, D. Ahmed, and P. Bezbaruah	<i>Tools:</i> Android studio, Google map engine modules. <i>Libraries:</i> Manifests, Context, Intent, Package manager, Location, Firebase, Button, IBinder.
[9]	2023	WSA: A Navigation App for Women Safety	R. Jayabhaduri, S. Saineha, M. Madhumithaa, and A. Roshini	<i>Tools Used:</i> Google Directions Service API for map interface, Kotlin for user verification, WSA dataset, Android Studio IDE, Optical character recognition (OCR).
[10]	2020	IoT Based Women Security: A Contemplation.	Deepinder Kaur, Ravita Chahar, and Jatinder Ashta	The paper presents a wearable IoT device for women that send alerts with the location to emergency contacts in real-time.

III. CONCLUSION

The conclusion of the paper underscores the urgent need for effective safety solutions in response to the increasing instances of gender-based violence. It highlights the significance of wearable safety devices as essential tools for enhancing women's safety by providing immediate assistance in emergencies. While it acknowledges challenges such as privacy concerns and accessibility, it also points to the potential of future technological advancements—particularly through artificial intelligence and the Internet of Things—to improve these devices. Ultimately, it advocates for continued innovation and awareness to empower women, helping them navigate their lives with greater confidence and security.

Furthermore, the conclusion calls for a collaborative effort among technologists, policymakers, and

communities to raise awareness and educate the public about these safety devices. This holistic approach will not only foster greater acceptance and usage but also contribute to creating safer environments where women can confidently engage in their daily activities. By persisting in innovation and advocacy, society can work towards a future where women's safety is a top priority, supported by effective technological solutions.

IV. FUTURE SCOPE

The future of women safety devices looks bright, fueled by technological advancements and an increasing awareness of gender-based violence. There are several key areas that offer opportunities for further research and development.

- *Integration of Advanced Technologies:* AI and ML integration can significantly further

the predictive capabilities of safety devices, allowing them to assess possible threats based on a user's behavior and environmental conditions. This would lead to proactive safety measures whereby a user is warned before a hazardous situation occurs.

- **Better Connectivity:** Future devices could use the Internet of Things to create a network of interlinked safety solutions. This would ensure seamless interoperability between wearables, mobile applications, and emergency services, guaranteeing faster responses and better situational awareness.
- **User-Centric Design:** Ongoing research into user experience will be essential for ensuring safety devices are not only highly effective but also user-friendly and easy to integrate into everyday life. Future designs should focus on the devices' aesthetic appeal, ease of wear, and adaptability to various lifestyles and personal preferences.
- **Wider Access:** For safety devices to make a real difference, they must be accessible to women from different economic backgrounds. Further studies should focus on finding affordable solutions, community-based programs, and partnership opportunities to distribute these devices to those in need.
- **Education and Awareness Programs:** With new devices still in development, educational programs will be a key in helping users learn how to work with these technologies. Future efforts should include extensive awareness campaigns demonstrating the benefits of wearable safety devices and their usability.
- **Longitudinal Studies:** Long-term studies are urgently needed to accurately assess the real-world effectiveness and impact of wearable safety devices on women's safety and well-being. This research will provide insights for future improvements and best practices in designing and implementing these technologies.

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