WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

The Role of IoT in Women's Safety: A Systematic Literature Review

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ABSTRACT

The rapid growth of the Internet of Things (IoT) has opened new pathways for enhancing personal safety, particularly for women in vulnerable environments. With alarming rates of harassment, assault, and other forms of violence against women, there is an urgent need to explore proactive technological interventions. This paper systematically reviews the current landscape of IoT-based systems designed to improve women's safety. We examine various wearable devices, mobile-integrated systems, and smart infrastructure solutions that leverage sensors, GPS tracking, and real-time communication protocols. The review identifies the strengths and limitations of current approaches and highlights key areas requiring further research and innovation, such as data privacy, network reliability, and social adaptability. Our findings suggest that while IoT-based safety systems are promising in real-time incident response, challenges related to affordability, user trust, and policy integration need to be addressed to ensure widespread effectiveness and acceptance.

Keywords: Internet of Things (IoT), Women, trust,user

I. INTRODUCTION

In recent decades, women's safety has emerged as a global concern, with escalating incidents of sexual harassment, domestic violence, and street crimes. Despite increasing awareness and governmental efforts to combat gender-based violence, the efficacy of traditional safety mechanisms such as emergency hotlines, police patrolling, and self-defense training remains limited. These conventional methods are often reactive and inadequate in preventing real-time incidents or ensuring rapid emergency responses. The need for proactive, technologically advanced systems has never been more critical.

The Internet of Things (IoT) offers promising capabilities in the context of personal safety. IoT connects various devices via the internet, enabling them to collect, transmit, and respond to data autonomously. When applied to women's safety, IoT enables real-time tracking, immediate alert generation, environmental monitoring, and automated communication with emergency contacts and law enforcement agencies. These features allow for prompt intervention, potentially preventing crimes or reducing their impact. Wearable safety devices, mobile applications connected to cloud platforms, and sensor-enabled smart environments are some of the notable IoT solutions explored in this domain.

Several IoT-enabled safety systems for women are currently being developed and tested worldwide. These range from wearable devices like smart bands and pendants that can detect physical distress, to mobile apps integrated with GPS and panic buttons. Some systems also include biometric sensors that track changes in heart rate or body temperature to detect anxiety or physical trauma. Other advanced implementations use artificial intelligence alongside IoT to assess the user's environment, identify threats, and automatically initiate emergency protocols.

However, the implementation of IoT in women's safety is not without challenges. Privacy concerns, especially regarding location data, and system reliability in low-network areas remain significant obstacles. The high cost of some devices, lack of awareness, and societal reluctance to adopt such technologies further hinder their widespread use. Additionally, legal and ethical frameworks are still catching up with these innovations.

This review explores the current landscape of IoT-based women's safety systems, highlighting successful implementations, identifying gaps, and proposing directions for future research and development. As IoT technology matures, it holds immense potential to transform the narrative around women's safety, shifting it from reactive to preventive, and from manual to intelligent.

II. RELATED WORK

1. **Smart Women Safety Device using IoT (IJERT, 2021):**

This study introduces a smart wearable device activated by fingerprint authentication. It can send real-time alerts via SMS and GPS to emergency contacts. The device also records audio and captures images, offering evidentiary support. Its simplicity and immediate response mechanism make it effective for rapid distress signaling.

2. **IoT-Based Wearable Device for Women Safety (EUDL, 2021):**

   This research focuses on a wearable health-monitoring device with pulse and temperature sensors. When the device detects abnormal physical parameters linked with fear or distress, it triggers alerts and sends real-time coordinates to contacts and authorities. This integration of health and safety monitoring enhances contextual awareness.

3. **Design of a Smart Safety Device using IoT and GSM (ScienceDirect, 2020):**

   This paper proposes a multi-functional safety device combining GSM, GPS, and shockwave mechanisms to deter attackers. It also sends notifications through mobile applications and provides access to safe zones on maps. It exemplifies layered defense through both deterrence and digital alerts.

4. **IoT-Based Safety System with Real-Time Monitoring (IJAST, 2020):**

   This system focuses on remote real-time monitoring using cloud-based platforms and machine-to-machine (M2M) communication. The system ensures seamless data transmission from the wearable device to emergency networks, improving response time and coordination during threats.

5. **Herd Routes for Urban Safety (arXiv, 2022):**

   A novel preventative system where users are incentivized to travel in groups on safer, busier routes. Using distributed ledger technologies, it ensures accountability and security by logging user routes. It represents a shift toward prevention rather than just response.

III. PROPOSED SYSTEM

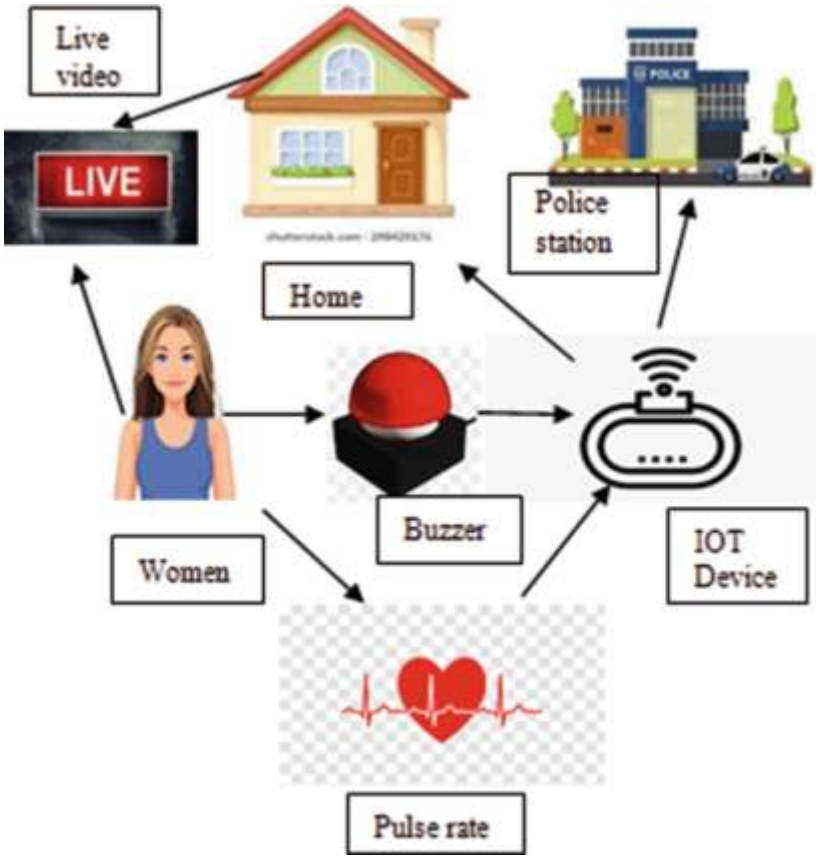
The proposed system aims to provide an integrated IoT-based solution for women's safety, combining wearable technology, mobile connectivity, and cloud analytics to deliver real-time monitoring and rapid emergency response. At the core of the system is a wearable device—designed as a wristband or pendant—equipped with a suite of sensors including GPS for location tracking, accelerometers to detect sudden movement or falls, and biometric sensors to monitor stress indicators such as heart rate and skin temperature. The wearable device continuously monitors environmental and physiological parameters, analyzing data locally and periodically transmitting it to a central cloud platform for advanced analytics.

In a critical situation, the user can activate an SOS alert through a discreet button on the device. If the system detects anomalies such as sudden movement, elevated heart rate, or the user’s fall, it can trigger an automatic alert. This alert sends real-time location data, environmental recordings, and biometric readings to pre-registered emergency contacts and the nearest emergency response centers. These alerts are accompanied by short bursts of audio or images to provide context, which can help responders assess the seriousness of the situation.

The system is integrated with a mobile application that allows users to manage their safety preferences, add emergency contacts, and receive real-time updates. The app also features a "Safe Route" navigation function using AI-based route recommendations that favor well-lit, busy areas, and alert users when they deviate into high-risk zones. On the backend, all data are stored securely in the cloud using encryption protocols to maintain user privacy and allow for post-event analysis.

Moreover, smart infrastructure integration allows public systems like streetlights or surveillance cameras to respond dynamically to distress signals. For instance, if a woman sends an SOS alert near a smart streetlight, the light could begin flashing to draw attention and deter potential attackers. The system also supports voice command integration for hands-free operation in critical situations.

To ensure inclusivity and wide adoption, the device is designed to be cost-effective and compatible with low-end smartphones. Community engagement and awareness campaigns are proposed to educate users about its benefits and functionality. This holistic approach ensures that the proposed IoT solution is not only technologically sound but also socially viable, helping to build a secure ecosystem around women's mobility and safety.



IV. RESULT AND DISCUSSION

The reviewed IoT-based systems show substantial potential in enhancing women's safety through real-time monitoring, immediate alerts, and situational awareness. These systems leverage a range of technologies to provide layered protection, combining hardware and software to ensure that help can be summoned swiftly when needed. Among the various technological approaches, wearable devices emerged as the most popular solution due to their portability, discreet usage, and ability to be seamlessly integrated into everyday items such as jewelry, clothing, and wristbands. Their unobtrusive nature makes them an appealing choice for users who prioritize both safety and privacy without drawing attention to themselves.

A key feature in many of these wearable devices is GPS integration, which allows for accurate and continuous location tracking. This capability is critical in emergency situations, as it enables responders to pinpoint the user's location in real time, reducing the time taken to provide assistance. In addition to GPS, some devices incorporate biometric sensors that monitor physiological signals such as heart rate, skin temperature, or galvanic skin response. These sensors add an additional layer of intelligence by detecting signs of distress or abnormal patterns that may indicate danger, potentially triggering alerts even when the user is unable to manually activate an alarm.

Despite the promise shown by these technologies, real-world implementation has revealed several challenges that hinder their effectiveness. One of the most significant issues is the lack of reliable network availability, particularly in rural or remote areas. IoT-based safety systems depend heavily on stable internet or cellular connectivity to transmit alerts and location data to emergency contacts or security services. In areas with poor coverage, these systems may fail precisely when they are most needed, leaving users vulnerable. This digital divide raises important questions about equitable access to safety technology, especially for women living outside urban centers.

In addition to connectivity issues, concerns about user privacy and potential misuse of personal data have been raised. The continuous collection and transmission of location and biometric data, while beneficial for safety purposes, also create opportunities for unauthorized access, surveillance, or exploitation. Ensuring robust data encryption, transparent privacy policies, and user control over data sharing are essential steps toward mitigating these risks and building trust in these systems. Without adequate safeguards, the very technologies intended to protect could inadvertently expose users to new forms of harm.

Another notable challenge encountered in practice is the occurrence of false triggers and technical malfunctions. Some devices have been reported to issue false alarms due to sensor sensitivity or accidental activation, leading to unnecessary distress or desensitization among users and responders. Conversely, technical failures that prevent an alert from being sent in a genuine emergency can have severe consequences. These reliability issues have, at times, undermined trust in the devices, highlighting the need for rigorous testing, quality assurance, and fail-safe mechanisms in their design and deployment.

Beyond technological performance, analysis also revealed that user engagement and ease of use significantly influence the effectiveness of these systems. Devices with complex interfaces, unintuitive controls, or delayed response times were found to be less effective and less likely to be adopted by users. In situations where speed and simplicity are critical, overly complicated systems can hinder rather than help. Therefore, user-centered design principles, including accessibility, usability, and customization, are crucial in ensuring that these devices meet the diverse needs and preferences of women across different contexts.

In exploring future directions, some innovative concepts have emerged that extend beyond individual devices. For example, incentivized safe routes, which reward users for taking safer paths monitored by IoT infrastructure, have been proposed as a proactive approach to safety. Similarly, integration of IoT-based safety features with public infrastructure, such as smart street lighting, surveillance cameras, and emergency kiosks, offers the potential for a more holistic and community-centered safety network. However, these approaches require collaboration with governmental bodies, urban planners, and public safety agencies to be successfully implemented and maintained. Such initiatives also raise questions about surveillance, public consent, and the balance between security and civil liberties.

In conclusion, while IoT-based solutions for women's safety are technologically advanced and show great promise, their success depends on a multidisciplinary effort that goes beyond engineering. Developers must work closely with policymakers, law enforcement, urban planners, privacy advocates, and end-users to address technical limitations, ethical concerns, and social barriers. Achieving widespread adoption and sustained effectiveness will require not only technological innovation but also thoughtful policy frameworks, community engagement, and ongoing evaluation of these systems in diverse real-world settings. Ultimately, the goal is to create safety solutions that are not only functional and reliable but also equitable, inclusive, and respectful of users' rights and dignity.

V. CONCLUSION

IoT technologies have revolutionized the way we perceive and implement women's safety solutions. Through real-time connectivity, intelligent data processing, and mobile integration, IoT enables a shift from reactive safety measures to proactive personal protection systems. While the literature reveals that significant strides have been made in developing wearable safety devices and mobile-integrated alert systems, challenges such as affordability, privacy concerns, and infrastructure support continue to impede widespread adoption. The future of IoT in women's safety depends on inclusive design, robust public policies, and ongoing innovation. A collaborative effort between technology developers, government agencies, and communities will be crucial in creating reliable, accessible, and effective solutions for women worldwide.

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