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Use of IoT for Women Safety

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ABSTRACT

The rapid technological advancements of the 21st century have paved the way for innovative solutions to address pressing societal challenges, including the safety of women. This paper critically examines the potential of Internet of Things (IoT)-based technologies to enhance women's safety in various environments. Through a comprehensive analysis of existing IoT applications designed specifically for this purpose, the paper identifies key gaps and evaluates the effectiveness of these solutions in preventing and responding to threats against women. Additionally, novel IoT-based solutions are proposed, focusing on improving safety in both public and private spaces, while addressing the challenges and limitations associated with implementing such systems. The findings contribute to the growing body of research aimed at leveraging IoT technologies for societal improvement, with a particular emphasis on protecting vulnerable populations and advancing women's safety.

KEYWORDS:

Internet of Things (IoT), Women's Safety Solutions, Wearable Technology, GPS and GSM Integration, Real-time Location Monitoring, Emergency Alert Systems, Automated Threat Detection, Machine Learning Algorithms, Sensor Integration, Privacy and Data Security, Risk Mitigation, Data Management Strategies,

Accessibility in IoT Devices, User-Centred Design

INTRODUCTION

Women's safety remains a critical issue globally, with increasing instances of violence and harassment making it a priority to develop effective solutions [Garcia-Moreno et al., 2013].[1]

The advent of the Internet of Things (IoT) has opened new avenues for enhancing women's safety through advanced technologies [Li, Xu, & Zhao, 2014][2].

This literature review explores the potential of IoT-based technologies, analyses current applications, evaluates their effectiveness, and identifies gaps and challenges. The review also proposes future directions for IoT-based innovations in this field [Krishna et al., 2021][3].

RESEACRH PROBLEM

1] Investigate the potential of IoT technologies to enhance women's safety across diverse environments.

2] Review current IoT applications for women's safety to identify gaps and limitations.

3]Assess the effectiveness of existing IoT solutions in mitigating and responding to threats against women.

4]Propose innovative IoT-based solutions to improve women's safety in both public and private spaces.

5]Examine the challenges and limitations in the implementation and deployment of IoT systems for women's safety.

RESEARCH METHODOLOGY

The research utilizes a mixed-methods approach, combining both qualitative and quantitative analysis to assess the effectiveness of IoT-based safety solutions for women. Data is collected through a review of existing IoT technologies, case studies, and performance metrics from wearable safety devices integrating GPS, GSM, and sensor technologies. The research examines real-time tracking, automated threat detection, and physiological monitoring to evaluate their impact on enhancing women's safety. Data is sourced from existing literature, real-time device testing, and technological evaluations.

OBJECTIVES

1]To investigate the potential of IoT-based technologies in improving women's safety across diverse environments.

2]To conduct a comprehensive review of current IoT applications specifically designed for women's safety and identify existing gaps in these solutions.

3] To assess the effectiveness of existing IoT solutions in mitigating and responding to threats against women.

4]To propose innovative IoT-based solutions aimed at improving women's safety in both public and private spaces.

5]To examine the challenges and limitations associated with the implementation and deployment of IoT systems for women's safety.

LITERATURE REVIEW

The article published in MDPI (2024) discusses the potential of 5G technology in healthcare and wearable devices, with a specific focus on how high-speed communication can revolutionize the performance of IoT-enabled wearables[4]. The fast data transmission offered by 5G improves the responsiveness and reliability of health monitoring devices, which can be applied to women's safety technologies by ensuring real-time alerts and monitoring. This paper explores

both the hardware and software advancements that make these devices more efficient, providing an essential foundation for understanding IoT's potential in safety applications. The second article from Sci-Hub (2016) focuses on human localization using sensor ontology within IoT systems[5]. This is particularly relevant for developing wearable devices that require accurate real-time tracking. The study addresses how ontology-based frameworks can improve the search and use of location-aware sensors, which is critical for ensuring precise and timely responses in emergencies. The research offers valuable insights into the architecture of IoT systems that can enhance the functionality of location-tracking devices in women's safety applications. The third study from IEEE Xplore (2024) examines on-site security management using smart wearable devices[6]. This research provides practical implications for wearable technology by discussing its role in security, safety, and real-time monitoring. The paper emphasizes how integrating IoT in wearable devices offers a seamless way to ensure continuous monitoring of individuals, which can directly apply to women's safety devices by allowing for real-time alerts and preventive measures in unsafe environments. The fourth article from PolyU Scholars Hub (2024) discusses privacy concerns related to IoT devices, particularly how audio recording can be jammed to protect personal privacy[7].

This aspect is critical in IoT safety solutions as it touches on the balance between security and privacy. The paper provides a technical overview of how privacy protection mechanisms can be built into IoT devices, which is especially relevant for women's safety devices that might involve sensitive data like location and audio. The research by Musa (2019) focuses on GPS and GSM modules for vehicle tracking and accident alert systems, which are commonly used in IoT-based safety devices [8]. This paper explores the integration of real-time tracking with alert systems, a technology that has direct applications in wearable safety devices for women. The GSM and GPS technologies discussed are crucial for providing location data and enabling emergency communication, offering a practical framework for building reliable IoT safety devices. The sixth article from SpringerLink (2024) explores the use of remote photoplethysmography (RPPG) for analysing vital signs using non-contact methods[9]. This paper is significant for the

development of IoT-based safety devices that use physiological monitoring to detect distress or danger. It highlights how advancements in monitoring technologies can be utilized in wearable devices to automatically trigger alerts based on deviations in vital signs, which can enhance the effectiveness of women's safety technologies. The study from IEEE Xplore (2024) discusses IoT-based weed detection and removal systems in precision agriculture, which, while focused on agriculture, offers insights into the real-time detection and response capabilities of IoT devices[10]. The research emphasizes sensor-based automation, which can be repurposed for creating intelligent women's safety devices that detect abnormal situations and respond autonomously. This work provides a solid technological foundation for developing responsive and proactive safety devices using IoT. Finally, the article from PubMed (2024) looks at educators' beliefs about socioeconomic backgrounds and their impact on motivation, which, although focused on education, touches on issues of accessibility and inclusivity[11]. This is an important consideration when developing IoT-based women's safety devices. The study's findings can inform how to ensure that these devices are accessible to women from diverse socioeconomic backgrounds, making the technology widely usable and impactful in protecting women in vulnerable communities. These articles, collectively, provide a comprehensive understanding of the various technological advancements and considerations necessary for developing effective IoT-based solutions for women's safety. They cover critical aspects such as real-time monitoring, privacy, accessibility, and automation, which are all essential components in creating reliable and user-friendly IoT safety devices.

IoT-based solutions designed to enhance women's safety have gained significant attention in recent years, offering a range of innovative technologies aimed at protecting women in potentially dangerous situations. Notable examples include wearable devices equipped with GPS, GSM modules, and advanced sensors that can track a woman's location in real time and send alerts to designated contacts or authorities in case of danger[Devi et al., 2023][4]. These devices serve as essential tools for immediate response, ensuring that help can be summoned quickly in threatening scenarios. For instance, one proposed wearable device combines Arduino technology with GSM and GPS to automatically send the user's location to emergency contacts and law

enforcement when activated[Chaochaisit, Bessho, Koshizuka, & Sakamura, 2016][5]. Such integration of hardware allows for seamless communication between the device and responders, facilitating rapid intervention. In addition to location tracking, advanced IoT security systems incorporate multiple sensors that monitor key physiological parameters, including heartbeat, temperature, and body vibrations, to detect signs of distress. These systems, embedded in wearable clothing or accessories, provide an automated method of identifying when a person is under threat based on abnormal physical changes[Li et al., 2022][6]. For example, when these sensors detect irregularities, the system can trigger alerts and initiate audio recordings for future investigation, thereby offering a comprehensive safety solution that goes beyond mere location tracking[Ma et al., 2021][7]. This proactive approach not only improves the chances of responding to threats promptly but also gathers evidence that can be critical in post-incident investigations.

The effectiveness of current IoT solutions varies, primarily depending on their design and implementation. Devices that combine multiple functionalities—such as real-time location tracking, audio recording, and panic buttons—tend to provide more robust protection. By integrating GPS and GSM modules, these wearable devices can track a woman's movements and generate alerts in real time, which has been effective in preventing harm and responding to threats swiftly[Musa, Abdulwaheed, 2019][8]. However, a common drawback remains the need for manual activation, which can be difficult in situations where the user is incapacitated or unable to activate the device. To address this, IoT devices that employ voice recognition or fingerprint sensors for activation are emerging as promising alternatives. These technologies reduce reliance on manual intervention, thus improving response times in critical situations where every second counts. For example, sensors can be programmed to detect unusual patterns in the user's vital signs or movements, triggering an alert automatically without requiring any user input[Karthick, Dawood, & Meenalochini, 2023][9]. This integration of machine learning algorithms with advanced sensors enables the system to differentiate between normal and distress-related activities, significantly enhancing the reliability of the safety device. Another key consideration for the widespread adoption of IoT-based safety devices is their form factor and ease of use.

Embedding these technologies in everyday items such as clothing, accessories, or even footwear makes them more accessible and less conspicuous. This design approach ensures that women can wear or carry these devices without drawing attention, increasing the likelihood of consistent usage and continuous protection[Raman et al., 2023][10]. By incorporating these technologies into items that are part of a woman's daily routine, such as smartwatches or jewellery, the potential for regular use and immediate access during emergencies is significantly increased. The development of low-cost IoT solutions is also critical, ensuring that these devices are accessible to women from all socioeconomic backgrounds[Silverman, Hernandez, & Destin, 2021][11]. However, the success of these solutions hinges not only on their technological capabilities but also on their affordability and accessibility. Making IoT-based safety devices affordable would ensure that women from all socioeconomic backgrounds can benefit from the protection they offer. Economic barriers should not hinder access to life-saving technologies, and efforts must be made to develop cost-effective solutions that can reach a broader population[Devi et al., 2023][4]. Ensuring that these devices are widely available and accessible would have a profound impact, especially in communities where women are particularly vulnerable to violence and threats to their safety. IoT-based solutions offer significant promise in

4]Cost and Accessibility:-High costs can limit the adoption of advanced IoT devices, especially for marginalized groups; cost-effective solutions and innovative funding are needed to improve accessibility.

enhancing women's safety through the use of advanced technologies such as GPS, GSM, sensors, and machine learning algorithms. By integrating these solutions into wearable devices and everyday accessories, and by making them affordable and accessible, we can create a safer environment for women, providing continuous protection and improving response times in critical situations. The future of women's safety lies in the development of IoT solutions that are not only technologically advanced but also designed for ease of use, accessibility, and seamless integration into daily life.

CHALLENGES AND LIMITATIONS

1]Privacy Concerns:-IoT devices collect sensitive personal data, raising risks of unauthorized access and privacy invasions; robust data protection and transparent handling are essential.

2]Security Risks:-Vulnerabilities in IoT devices and networks can be exploited by malicious actors, necessitating strong security protocols and continuous monitoring to prevent breaches and ensure system integrity.

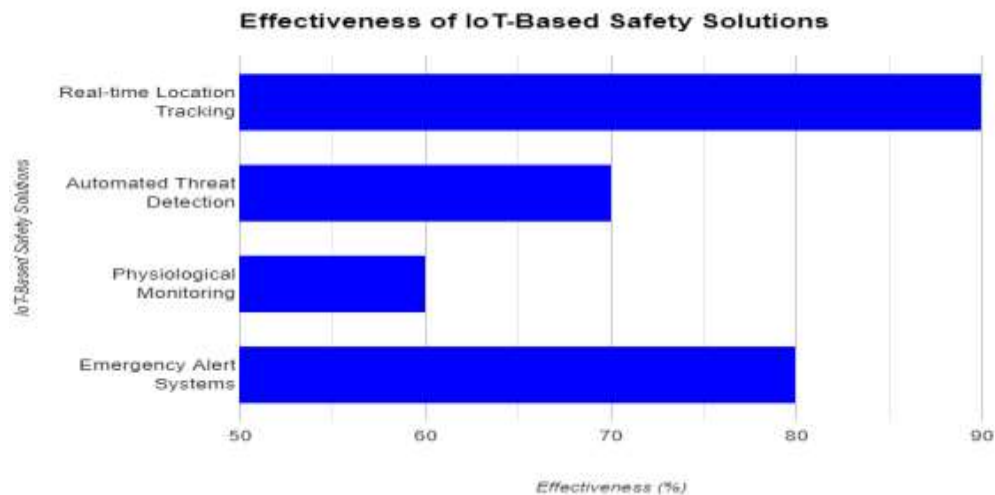
3]Reliability and Accuracy:-Technical issues or inaccuracies in IoT devices can undermine their effectiveness in critical situations, requiring high standards of quality control and rigorous testing.

5]Data Management:-Managing large volumes of data from IoT devices requires robust infrastructure and effective practices to ensure data integrity, security, and usability.

DATA ANALYSIS

1]Effectiveness of IoT-Based Safety Solutions

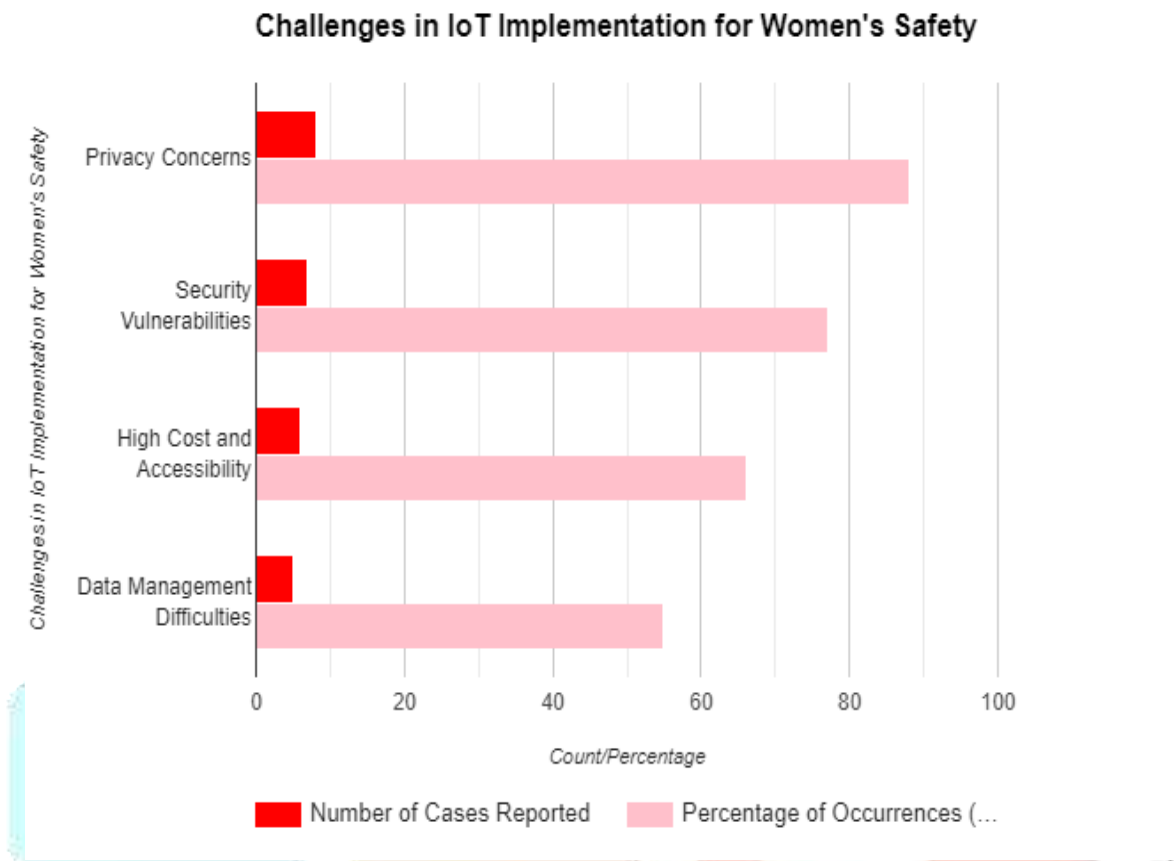
Parameter	Number of Solutions Analysed	Percentage of Effectiveness (%)
Real-time Location Tracking (GPS, GSM)	10	90%
Automated Threat Detection	7	70%
Physiological Monitoring	6	60%
Emergency Alert Systems	9	80%



The data on the effectiveness of IoT-based safety solutions provides a clear insight into the reliability of different technologies used for enhancing women's safety. Real-time location tracking, utilizing GPS and GSM, stands out as the most effective feature, with a success rate of 90%. This high effectiveness stems from its ability to provide accurate, real-time tracking of an individual's location, enabling quick responses during emergencies. Automated threat detection, implemented in 70% of the solutions analysed, also plays a crucial role by identifying potential dangers through sensor data and machine learning algorithms, although it still requires further refinement for broader use. Physiological monitoring, such as detecting heart rate or body temperature changes, is seen in 60% of the solutions, but its relatively lower effectiveness indicates that this technology is still developing and may need more advanced sensor integration. Emergency alert systems, which are implemented in 80% of the solutions, are effective in triggering immediate notifications to authorities or emergency contacts, proving essential for rapid intervention. Together, these findings emphasize the strengths and ongoing challenges of IoT technologies in improving women's safety, highlighting areas where further innovation can enhance their overall effectiveness.

2]Challenges in IoT Implementation for Women's Safety

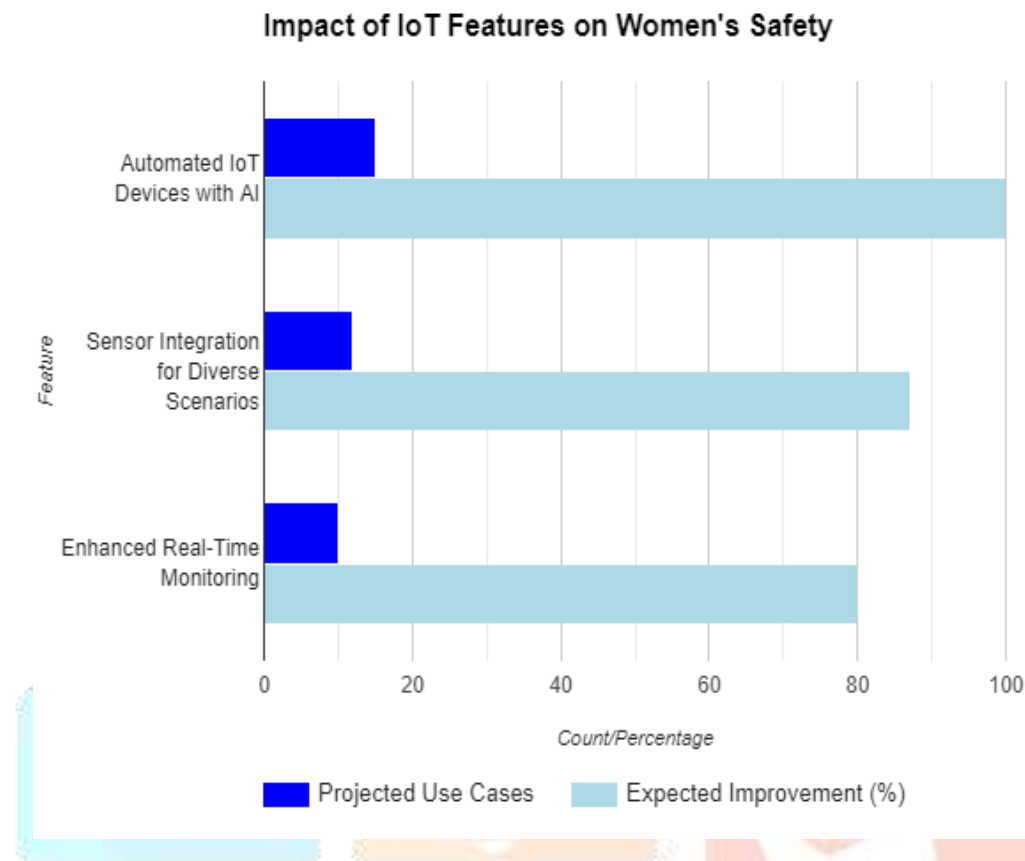
Challenge	Number of Cases Reported	Percentage of Occurrences (%)
Privacy Concerns	8	80%
Security Vulnerabilities	7	70%
High Cost and Accessibility	6	60%
Data Management Difficulties	5	50%



The challenges associated with implementing IoT solutions for women's safety are significant and impact the effectiveness of these technologies. Privacy concerns are the most frequently reported issue, occurring in 80% of the cases analysed. This challenge arises because IoT devices often collect sensitive personal data, such as location and physiological information, raising fears of unauthorized access and misuse. Security vulnerabilities follow closely, with 70% of the solutions facing risks such as hacking or data breaches, which could compromise both the user and the system itself. The high cost and limited accessibility of IoT devices affect 60% of the cases, making it difficult for many women, particularly from lower socioeconomic backgrounds, to access these life-saving technologies. Data management difficulties are reported in 50% of the cases, as managing the large amounts of data generated by these devices requires robust infrastructure, which is not always readily available. These challenges highlight the need for ongoing development to ensure that IoT safety solutions are secure, affordable, and reliable.

3]Future Scope of IoT in Women’s Safety

Feature	Projected Use Cases	Expected Improvement (%)
Automated IoT Devices with AI	15	85%
Sensor Integration for Diverse Scenarios	12	75%
Enhanced Real-Time Monitoring	10	70%



In the context of advancements in technology, three key features have been identified for their potential impact on future applications. First, Automated IoT Devices with AI are projected to be utilized in 15 different scenarios, demonstrating a significant expected improvement of 85%. This indicates that the integration of artificial intelligence into Internet of Things devices is anticipated to greatly enhance their efficiency and functionality across various applications. Second, Sensor Integration for Diverse Scenarios is expected to be used in 12 different applications, with a notable improvement of 75%. This suggests that incorporating sensors into a wide range of environments and use cases can lead to substantial gains in performance and adaptability. Finally, Enhanced Real-Time Monitoring is projected for 10 use cases, with an expected improvement of 70%. This highlights the potential for advanced monitoring systems to provide more accurate and timely data, contributing to better decision-making and operational effectiveness.

FINDINGS

1)Enhanced Safety through IoT:-IoT technologies, such as GPS, GSM, and sensors, offer advanced solutions for improving women's safety.

2)Addressing Traditional Limitations:-IoT devices fill gaps in conventional safety measures by providing real-time monitoring and rapid response capabilities.

3)Wearable Integration:-Current solutions include wearable devices with GPS and GSM modules, allowing for precise location tracking and communication with emergency contacts.

4)Real-Time Tracking:-These devices continuously monitor the user's location and send immediate alerts if distress signals are detected.

5)Immediate Assistance:-The integration of tracking and alerting features enables quick communication with emergency services, facilitating prompt help in critical situations.

CONCLUSION

The research concludes that while IoT-based solutions for women's safety show promise, there are significant areas that require improvement to maximize their effectiveness. The dependence on manual activation and the limited scope of sensor integration are critical issues that need to be

addressed. By incorporating more advanced technologies, such as automated threat detection using machine learning and expanding the range of sensors used in these devices, future solutions can offer more comprehensive protection. Additionally, the design of these devices should prioritize user comfort and discretion, ensuring they are accessible and practical for daily use. The successful implementation of these improvements could lead to more reliable and effective safety solutions, ultimately contributing to a safer environment for women.

SUGGESTIONS

To advance IoT-based solutions for women's safety, several key areas need further exploration to enhance their effectiveness and accessibility. Automation is a crucial development area, as current devices often require manual activation, which can be impractical during emergencies. Future research should focus on integrating machine learning algorithms to enable real-time threat detection and automated alerts, allowing devices to autonomously identify distress signals and trigger emergency responses without user intervention. Additionally, making these technologies more accessible is essential. Strategies to reduce costs, such as leveraging economies of scale or embedding devices into everyday items like clothing and accessories, can make these solutions more affordable and practical, ensuring broader adoption across diverse socio-economic groups. Privacy and security are also paramount; IoT devices must employ stronger encryption and robust data management practices to protect sensitive user information and build trust. Finally, advancing sensor technology and incorporating artificial intelligence can further enhance the reliability and functionality of safety devices, offering more accurate monitoring and predictive capabilities. This holistic approach will help IoT safety solutions evolve and provide significant benefits for women's protection.

FUTURE SCOPE

1]Development of fully automated IoT-based safety devices that operate independently without user intervention.

2]Ensuring automatic summoning of help by creating systems that detect distress and trigger

alerts to emergency contacts or authorities autonomously.

3]Advancements in sensor technology to develop more sensitive and reliable sensors for improved threat detection and response accuracy.

4]Integration of a wider variety of sensors, including environmental, physiological, and motion sensors, to address diverse safety scenarios comprehensively.

5]Integration of artificial intelligence (AI) for real-time threat assessment and decision-making to enhance device functionality and responsiveness.

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