iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: I Month of publication: January 2025

DOI: https://doi.org/10.22214/ijraset.2025.66186

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue I Jan 2025- Available at www.ijraset.com

A Review on Powering Women's Safety with Step-Generated Energy

Lilesh Lahre[1], Aastha Sahu[2], Aastha Tripathi[3]
[1, 2]B.Tech Students, Assistant Professor, Department of Computer Science Engineering
Government Engineering College Bilaspur C.G.

Abstract: This paper reviews the innovative IoT-enabled footwear prototype for enhancing women's safety, leveraging piezoelectric energy harvesting to create a self-sufficient, energy-efficient solution. The footwear integrates advanced safety features such as GPS tracking, camera and microphone for evidence capture, and an SOS alert system, powered entirely by energy harvested from the wearer's steps. The development of this system highlights the potential for sustainable, autonomous, and user-centric safety technologies that can be seamlessly integrated into everyday life. This review covers the underlying technologies, the design process, and applications of this prototype, ultimately discussing the broader impact of such wearable safety solutions for women and their potential for integration into smart city ecosystems and humanitarian contexts.
Keywords
Wearable Safety, IoT, Energy Harvesting, Personal Safety, Smart Footwear, Women's Safety, Piezoelectric Sensors, Emergency Response, Sustainable Solutions, Smart Cities.

I. INTRODUCTION

Women's safety is a major concern globally, and technological innovation can play a key role in addressing this issue. Traditional safety solutions often rely on external devices or resources, which can be cumbersome and inefficient in emergencies. This paper presents a step-generated energy footwear prototype that utilizes piezoelectric energy harvesting to provide a self-powered, sustainable solution to enhance personal safety. The prototype integrates Internet of Things (IoT) capabilities, enabling continuous monitoring of the wearer's location, recording of evidence in case of an emergency, and quick communication with emergency contacts. These features, powered by the energy generated from the wearer's own movements, ensure the safety device remains operational without reliance on external power sources. The goal of this review is to assess the key innovations in this project, evaluate its effectiveness, and explore the broader implications for personal safety, wearables, and sustainable technology.

II. BACKGROUND AND MOTIVATION

Women's safety concerns persist across urban and rural environments, with threats ranging from street harassment to more severe violence. In response, a growing body of wearable technologies has emerged, aiming to enhance personal security. These devices typically include features such as location tracking, emergency alerting, and even surveillance capabilities [2]. However, most of these solutions require regular recharging or rely on external devices like smartphones, making them less practical in emergency situations where access to power may be limited.

Energy harvesting technologies, particularly piezoelectric sensors, have shown promise as sustainable power sources for wearables [3]. By capturing small amounts of energy from human motion, these systems can power small devices without the need for conventional batteries. The integration of energy harvesting with personal safety features represents a significant leap forward in wearable technology, offering both a self-sustaining and practical solution to personal security concerns.

III. OVERVIEW OF THE FOOTWEAR PROTOTYPE

The Powering Women's Safety with Step-Generated Energy footwear prototype integrates the following key components:

1) Piezoelectric Sensor: Embedded in the footwear sole, the piezoelectric sensor converts mechanical energy from the wearer's walking motion into electrical energy.
2) Energy Storage: The generated energy is stored in a rechargeable lithium-ion battery, ensuring a continuous power supply for the system's features.
3) GPS Tracking: Real-time location tracking provides emergency contacts with precise, live location data.

4) Camera and Microphone: These components allow for evidence capture (e.g., video and audio) in emergency situations, providing valuable data in case of harassment or violence.
5) SOS Alert System: A dedicated button or touch panel or AI enabled voice assistance enables the wearer to instantly send an alert to pre-programmed emergency contacts, transmitting location data and captured evidence.
6) IoT Integration: Wireless communication (via Bluetooth/Wi-Fi) allows the footwear to transmit data to a connected mobile app, ensuring real-time updates and alerts.

IV. LITERATURE REVIEW

Wearable technologies for personal safety, particularly for women, have gained significant attention in recent years, driven by the need for discreet, autonomous, and reliable solutions [1]. Devices such as smartwatches and safety bands, which incorporate GPS tracking and emergency alert systems, provide real-time location sharing and distress signal capabilities, enhancing personal security [2]. However, many of these devices face challenges such as dependency on external power sources and bulky designs, which can be impractical in emergencies. To address these issues, energy harvesting technologies, particularly piezoelectric systems, have emerged as a promising solution. Piezoelectric sensors, which convert mechanical energy from human motion into electrical power, offer a sustainable, self-sufficient power source, eliminating the need for external charging [3][4].

The integration of IoT with wearable safety systems further enhances their functionality by enabling real-time data transmission, location tracking, and communication with emergency services. IoT-enabled devices, often equipped with GPS, cameras, and microphones, improve emergency response times by allowing for evidence capture and more accurate interventions [5]. Additionally, the self-sufficiency of energy-harvesting wearables ensures they remain operational even in off-grid environments, making them ideal for resource-poor areas and disaster zones [4]. Research has shown that piezoelectric-powered wearables can continuously generate energy from simple activities like walking, supporting features like GPS tracking and emergency alerts without relying on external power sources, thus offering both convenience and sustainability.

The potential applications of these self-powered devices extend beyond personal safety, with the possibility of integration into smart city ecosystems.

Wearables could interact with smart infrastructure such as streetlights and surveillance systems, contributing to a more connected and responsive urban environment. Moreover, in humanitarian contexts, these devices could play a crucial role in disaster relief efforts, where reliable, self-powered safety solutions are essential [5]. Thus, the combination of wearable safety technologies, energy harvesting, and IoT has the potential to revolutionize women's security, offering sustainable, autonomous solutions for personal protection in diverse environments.

V. METHODOLOGY

The project was developed through several key stages:

A. *Design and Component Selection*

The design process began with an extensive literature review to identify gaps in existing safety technologies and energy harvesting solutions. The key challenge was to ensure that the components could be integrated into a single wearable device without compromising comfort or functionality. Components were carefully selected for their energy efficiency, miniaturization, and integration with wireless communication systems.

B. *Energy Harvesting System*

A piezoelectric sensor was integrated into the sole of the footwear, designed to convert walking motion into electrical energy. The power generated is conditioned and stored in a lithium-ion battery with a Battery Management System (BMS) to ensure optimal performance and longevity.

C. *System Integration*

A microcontroller was used to manage the system's operations, from energy harvesting to real-time communication with the mobile app. The GPS, camera, and microphone were integrated into the footwear to ensure that emergency alerts, evidence capture, and real-time location tracking could be executed seamlessly.

D. Prototyping and Testing
Once the design was finalized, a functional prototype was constructed, and initial field testing was conducted. The testing focused on usability, comfort, and the ability of the system to perform reliably during typical physical activities like walking or running. User feedback was gathered to assess comfort and practicality, leading to iterative refinements of the footwear.

VI. RESULTS AND EVALUATION

A. Energy Harvesting Efficiency
The piezoelectric sensor demonstrated sufficient power generation to fuel all integrated safety features during typical walking patterns. This self-sustaining power source proved reliable, making external charging unnecessary.

B. System Performance
The integration of GPS tracking, camera, microphone, and SOS functionality provided reliable real-time updates and emergency response capabilities. The system successfully transmitted alerts and location data to emergency contacts, while the evidence captures (video and audio) functioned effectively in emergency simulations.

C. User Feedback
Early user tests indicated that the footwear was comfortable and did not impede movement. Test participants expressed confidence in the system's ability to enhance their personal safety, particularly in high-risk environments.

D. Sustainability
The self-powered nature of the footwear ensured that the system remained operational in areas with unreliable power sources. This feature also contributed to the eco-friendliness of the system, reducing the environmental impact of traditional battery-dependent devices.

VII. APPLICATIONS AND IMPLICATIONS
The primary application of this footwear prototype is to enhance women's personal safety. The integration of IoT and energy harvesting opens up several possibilities:

A. Personal Safety
The footwear serves as a discreet, wearable safety device that provides real-time alerts, location tracking, and evidence capture without the need for additional devices like smartphones. This can be especially valuable in high-risk environments, such as urban areas or during late-night commutes, remote areas, households etc.

B. Emergency Response
The ability to send an instant SOS alert with precise location data enables faster and more accurate emergency responses. The inclusion of video and audio evidence also aids in incident documentation, assisting law enforcement in investigations.

C. Sustainable and Off-Grid Solutions
The piezoelectric energy harvesting system ensures that the footwear can function without external power sources, making it an ideal solution for off-grid environments or disaster zones, where access to electricity is limited.

D. Smart City Integration
As cities evolve into smart cities; this footwear could be integrated into broader urban safety networks. For instance, the system could communicate with smart streetlights or emergency services, further enhancing overall safety and response times.

E. Humanitarian Applications
The footwear's self-sufficiency and ability to provide safety features in resource-poor environments make it a potential tool for humanitarian efforts, especially in regions affected by conflict or natural disasters.

VIII. FUTURE DIRECTIONS

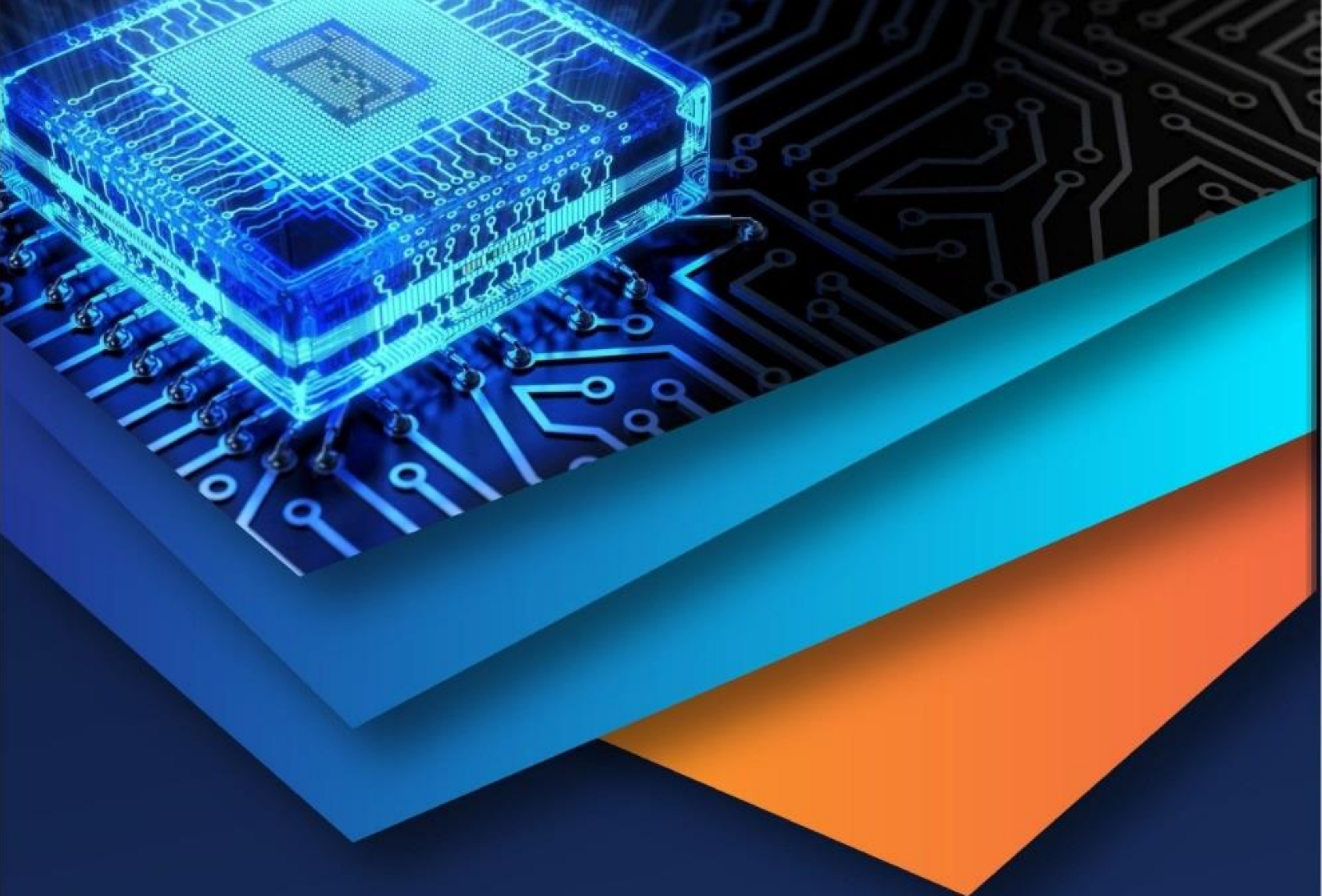
The future of this technology holds exciting potential, including enhanced sensor integration with accelerometers and environmental sensors (temperature, humidity) for more comprehensive monitoring, as well as AI and machine learning to analyze data for predictive alerts and threat detection based on movement patterns or environmental context. There is also the opportunity for global expansion, particularly in regions with limited or inconsistent power access, and the possibility of offering customizable designs to suit individual preferences or specific needs.

IX. CONCLUSION

The Powering Women's Safety with Step-Generated Energy project represents a significant innovation in the intersection of wearable technology, personal safety, and sustainable energy harvesting. By leveraging piezoelectric sensors, the footwear prototype offers a self-sustaining, practical solution to personal security, providing women with the tools to protect themselves in emergency situations. With further development, this project has the potential to significantly improve the safety, autonomy, and confidence of women in both urban and rural environments. Additionally, it lays the groundwork for integrating IoT-enabled safety solutions into the broader smart city ecosystem, contributing to the development of more connected, secure, and sustainable communities.

REFERENCES

[1] Bickmore, T., & Schulman, D. (2013). "A Longitudinal Study of a System to Monitor Patient Safety Using Wearable Technology." *Journal of Medical Internet Research*, 15(1), e11.
[2] Jin, L., et al. (2021). "Wearable Smart Technologies for Personal Safety and Security." *Sensors*, 21(16), 5522.
[3] Roundy, S., Wright, P. K., & Rabaey, J. M. (2003). "Energy Scavenging for Wireless Sensor Networks: A Survey." *Computer Communications*, 26(11), 1131–1144.
[4] Li, X., et al. (2020). "IoT-based Personal Safety Solutions for Women." *IEEE Access*, 8, 163716-163728.
[5] Yang, Y., et al. (2020). "Self-Powered Wearable Electronics and IoT Systems." *Nature Communications*, 11, 1083.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY