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A Smart Wearable Footwear Using IoT for Emergency Women Safety

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Abstract: Women's safety has become a critical concern due to the rising number of harassment and assault incidents, particularly in public and isolated areas. Conventional safety measures such as mobile applications and emergency helplines often fail to provide immediate assistance during panic situations. This paper presents the design and implementation of a **Smart Footwear System for Women Safety**, an IoT-based wearable solution that ensures continuous availability, discreet operation, and rapid emergency response.

The proposed system integrates a microcontroller, pressure or motion sensors, a GPS module, and a GSM communication unit embedded within footwear. The system can be activated either manually using a concealed switch or automatically through abnormal sensor activity. Upon activation, an emergency alert containing real-time location coordinates is transmitted to predefined contacts via GSM, while an audible buzzer is triggered to attract nearby attention.

The system is designed to be compact, low-power, and comfortable for daily use without affecting normal walking behavior. Experimental results demonstrate reliable alert transmission, accurate location tracking, and effective hardware–software integration. This wearable safety solution highlights the potential of IoT-enabled assistive technologies in addressing real-world societal challenges.

Keywords: Women Safety, Smart Footwear, IoT, GPS, GSM, Wearable Devices.

1. INTRODUCTION

Women's safety has emerged as a major societal challenge due to increased urbanization, late working hours, and dependence on public transportation. While safety applications and helplines exist, they often require user interaction through mobile phones, which may not be feasible during sudden or physically restrictive situations.

Wearable technology offers a promising alternative by embedding safety mechanisms directly into daily-use accessories. Footwear, worn continuously throughout the day, provides an ideal platform for such integration. A smart footwear system enables discreet activation, continuous availability, and real-time communication without drawing attention to the user.

This paper proposes a smart footwear system that integrates IoT-based communication and sensor technology to provide immediate emergency alerts along with precise location information.

2. LITERATURE REVIEW

Recent research highlights a growing interest in IoT-enabled wearable safety devices. Studies have explored GPS-GSM-based alert systems that transmit real-time location information during emergencies. Wearable devices such as smart bands, pendants, and footwear have been proposed to provide discreet activation mechanisms.

Footwear-based safety systems offer distinct advantages due to their constant usage and minimal visibility. Previous works demonstrate that embedding sensors and communication modules into footwear improves response time and

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usability compared to handheld devices. However, challenges such as power consumption, signal reliability, and user comfort remain areas of improvement.

The proposed system builds upon existing research by focusing on compact design, efficient power usage, and reliable emergency communication.

3. SYSTEM OVERVIEW

The Smart Footwear System consists of the following major components:

- Microcontroller (Arduino/ESP32)
- Pressure or motion sensors
- GPS module
- GSM module
- Emergency trigger switch
- Buzzer
- Rechargeable battery

The system continuously monitors sensor inputs. When danger is detected or the emergency switch is pressed, the system retrieves the user's current GPS location and sends an alert message to predefined contacts via GSM. Simultaneously, an audible buzzer is activated to attract nearby attention. Fig. 3.1.

4. HARDWARE AND SOFTWARE DESIGN

A. Hardware Components

The microcontroller acts as the central processing unit, coordinating sensor inputs and communication modules. Pressure or motion sensors detect abnormal activity. The GPS module provides latitude and longitude data, while the GSM module transmits emergency messages. A rechargeable battery supplies power, ensuring portability and long-duration operation. All components are embedded securely within the footwear using lightweight casing to ensure comfort and durability.

B. Software Implementation

The system is programmed using Embedded C through the Arduino IDE. The software continuously reads sensor values, processes GPS data, and controls GSM communication using AT commands. Debounce logic is implemented to avoid false triggers, and power management routines extend battery life.

The GPS module communicates using NMEA sentences, which are parsed to extract accurate location coordinates. GSM communication is handled using standard AT commands for SMS transmission. Only essential data—alert message and location—is transmitted to minimize delay and network overhead. The system incorporates retry mechanisms to ensure message delivery in moderate network conditions.

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Fig.4.1.

5. COMMUNICATION PROTOCOL AND DATA HANDLING

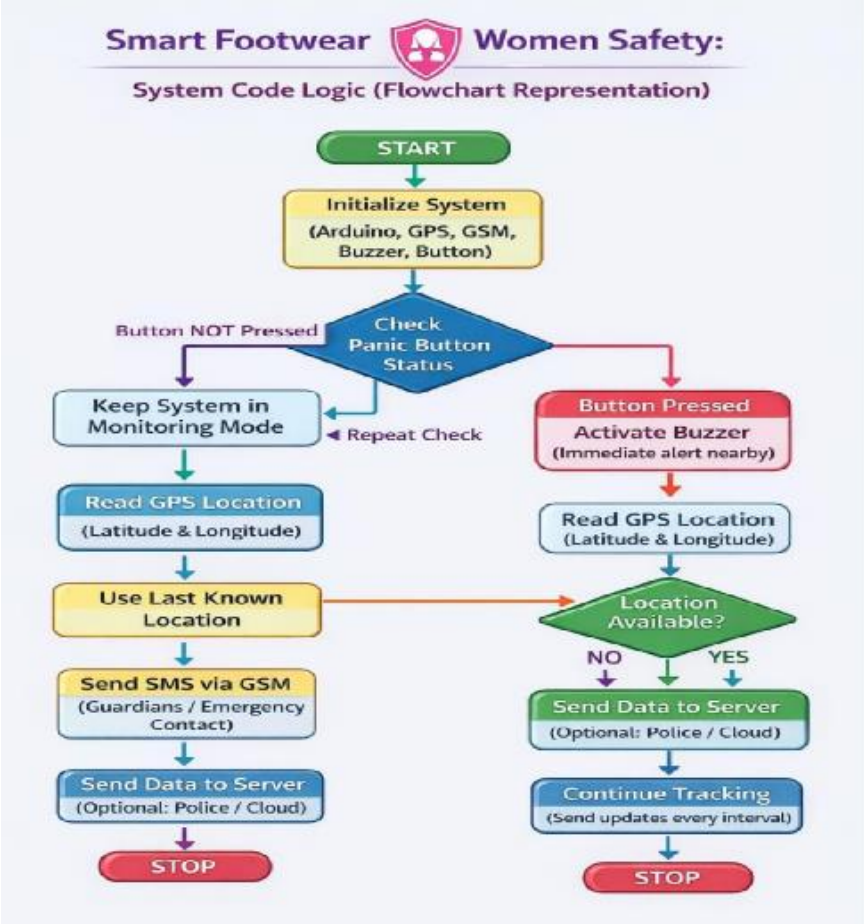

Fig.5.1.

6. RESULTS AND DISCUSSION

The proposed smart footwear system was successfully implemented and tested under various scenarios. The system accurately detected emergency triggers, retrieved real-time GPS coordinates, and transmitted alert messages reliably. The buzzer provided immediate audible feedback, enhancing safety.

Hardware–software integration was stable, and the system did not affect user comfort during walking. The results demonstrate that the system offers a practical, low-cost, and reliable solution for women's safety.

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Fig.6.1.

Fig. 6.2.

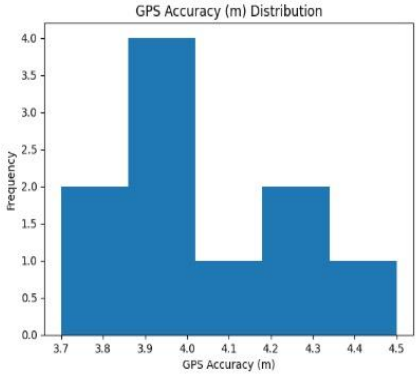

Fig. 6.3.

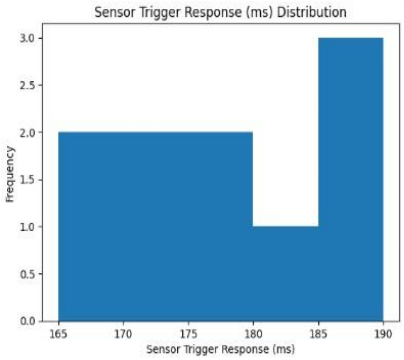

Fig. 6.4.

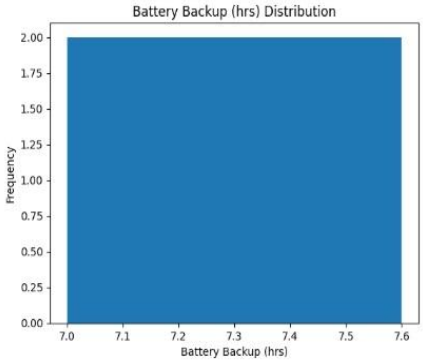

Fig. 6.5.

7. CHALLENGES AND SOLUTIONS

Key challenges included avoiding false alerts, maintaining reliable GPS and GSM connectivity, and ensuring low power consumption. These were addressed through sensor calibration, optimized component placement, external antenna usage, and efficient power management routines.

Durability issues due to constant movement were resolved by secure casing and insulated wiring.

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8. CONCLUSION

This paper presented an IoT-based Smart Footwear System for Women Safety that provides continuous, discreet, and reliable emergency assistance. By embedding sensors, communication modules, and alert mechanisms into footwear, the system ensures immediate response during critical situations.

The system demonstrates the feasibility of wearable safety solutions and provides a strong foundation for future enhancements such as mobile app integration and cloud-based monitoring.

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