As per UGC guidelines an electronic bar code is provided to secure your paper

International Journal for Modern Trends in Science and Technology
Volume 11, Issue 05, pages 951-955
ISSN: 2455-3778 online
Available online at: http://www.ijmtst.com/vol11issue05.html
DOI: https://doi.org/10.5281/zenodo.15335207

An IoT Based and Cloud Monitoring Smart Shoe for Blind People

Dr. Y. Neeraja, Chinta Vishnuvardhan, Mohammed Rehmath Fazil, Chenna Venkata Nitesh, Pasam Mohith

Department of Electronics and Communication Engineering, Narayana Engineering College, Gudur, Andhra Pradesh, India.

To Cite this Article
Dr. Y. Neeraja, Chinta Vishnuvardhan, Mohammed Rehmath Fazil, Chenna Venkata Nitesh & Pasam Mohith (2025). An IoT Based and Cloud Monitoring Smart Shoe for Blind People. International Journal for Modern Trends in Science and Technology, 11(05), 951-955. https://doi.org/10.5281/zenodo.15335207

Article Info
Received: 04 April 2025; Accepted: 29 April 2025.; Published: 05 May 2025.

KEYWORDS

IoT, Ultrasonic Sensors, Microcontroller, Smart Shoe, Assistive Technology

ABSTRACT

This paper presents an innovative IoT-enabled smart shoe designed to enhance the safety and awareness of visually impaired individuals. Equipped with ultrasonic sensors, the shoe detects obstacles within a predefined range, such as walls, steps, and uneven surfaces. Upon detection, the system generates audio feedback through a DFPlayer Mini, providing alerts like "Obstacle Detected" and "Moisture Detected." Additionally, an emergency feature is integrated using Google Routine, allowing a distress message to be sent to caregivers when triggered by a voice command like "Help." Real-time data, including step count, moisture level, obstacle count, and GPS location, is updated to the Ubidots cloud for monitoring. The integration of these features ensures timely alerts, enabling proactive navigation and minimizing risks associated with mobility. Designed for efficiency and ease of use, the smart shoe aims to improve confidence and safety while promoting greater independence in daily activities.

1. INTRODUCTION

This paper presents the development of an IoT-enabled smart shoe designed to improve the mobility and safety of visually impaired individuals. The system combines advanced sensors and IoT technology to deliver real-time obstacle detection, step counting, slip detection, and emergency support. By leveraging smart sensing mechanisms, the shoe assists users in navigating their environment with greater confidence, reducing the risks associated with movement in unfamiliar or hazardous conditions.

The smart shoe is equipped with ultrasonic sensors to detect obstacles such as walls, steps, and uneven surfaces. Upon detecting an obstacle, the system generates audio feedback through a DFPlayer Mini, providing alerts like "Obstacle Detected." A soil moisture sensor is included for slip detection, identifying wet surfaces that may pose a risk. When moisture is detected, an audio alert such as "Moisture Detected" is triggered to warn the user. Additionally, the step counting feature continuously tracks movement patterns, offering valuable insights into the user's daily activity levels and mobility trends. These features collectively enhance situational awareness, enabling users to make informed decisions while walking.

For enhanced safety, the system integrates an emergency alert mechanism using Google Routine. When the user issues a voice command like "Help," a distress signal is sent to caregivers, along with the real-time GPS location of the user. This ensures that immediate assistance can be provided in case of emergencies. Furthermore, all collected data, including step count, moisture level, obstacle detection, and location, is transmitted to the Ubidots cloud for remote monitoring. Caregivers can easily access this data through a user-friendly interface, enabling proactive intervention when necessary. With continuous advancements in IoT and sensor technology, this smart shoe represents a significant step toward empowering visually impaired individuals by improving their independence, safety, and overall mobility experience.

II. PROPOSED SYSTEM

The proposed system, "**An IoT-Based and Cloud Monitoring Smart Shoe for Blind People**" is designed to improve the mobility and safety of visually impaired individuals. It uses ultrasonic sensors for obstacle detection and a soil moisture sensor for slip detection. The system provides real-time audio alerts to warn users about potential hazards such as walls, steps, and wet surfaces. Additionally, it includes a step-counting feature and an emergency alert mechanism that sends the user's real-time GPS location to caregivers via the Ubidots platform [5] for remote monitoring. Designed to resemble regular footwear, the smart shoe is lightweight, rechargeable, and easy to use, offering a reliable and efficient navigation aid, as shown in fig.1.

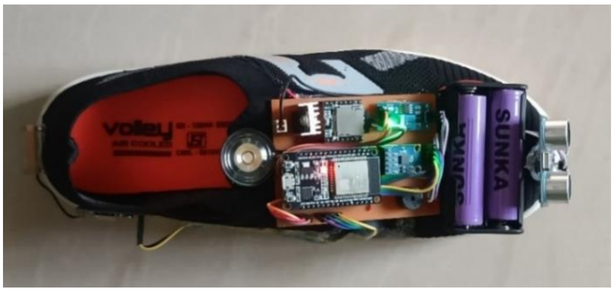

Fig.1: Prototype of the Smart Shoe Model

An interconnected system integrates multiple sensors, a microcontroller, and communication modules to collect and process data. Various components, including an ultrasonic sensor, pedometer, GPS module, moisture sensor, and emergency command input, provide real-time environmental and positional data. A power supply ensures continuous operation, while cloud connectivity enables remote monitoring and analysis.

A microcontroller, ESP-WROOM-32, processes incoming data from the sensors and triggers appropriate responses based on predefined conditions. It communicates wirelessly with the Ubidots platform, allowing real-time data transmission and analysis. The system facilitates automation, decision-making, and efficient data processing.

Immediate notifications are provided through a buzzer and an audio alert system using a DFPlayer Mini. Wireless communication ensures remote access to collected data, enhancing monitoring capabilities and response efficiency.

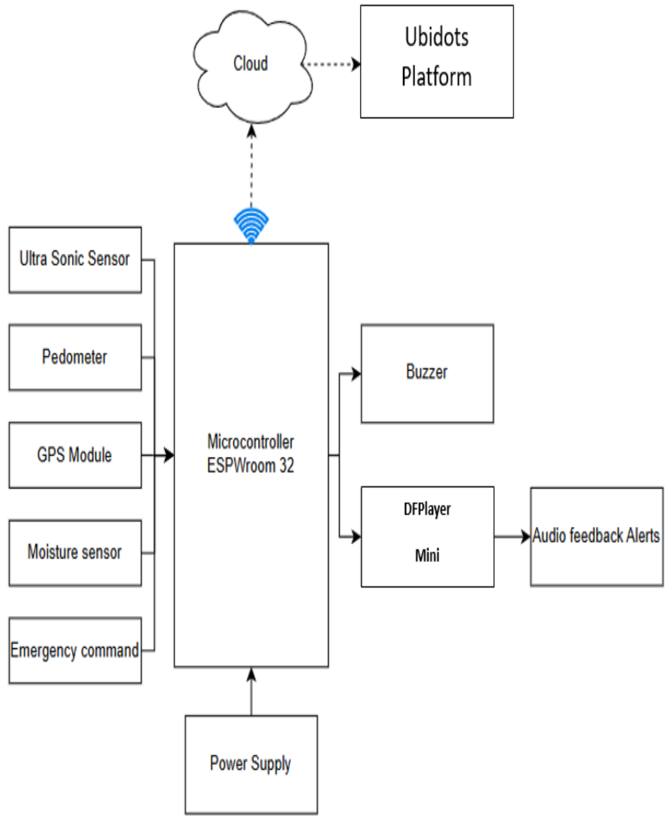

Fig.2: Block Diagram of Smart Shoe model

III. WORKFLOW

The smart shoe system starts by initializing the ESP32 microcontroller and connected sensors, ensuring proper communication between components. The system sets up serial communication, configures essential pins, and connects to Wi-Fi for data transmission through the MQTT client.

Once initialized, the system continuously monitors inputs from the following sensors:

1. **GPS Module:** Shares the user's real-time location to the Ubidots cloud via Wi-Fi.
2. **Ultrasonic Sensor:** Detects obstacles within 50 cm and triggers an audio alert like "Obstacle Detected" through the DFPlayer Mini while activating the buzzer.
3. **Pedometer:** Tracks the user's steps and updates the step count to the Ubidots cloud.
4. **Soil Moisture Sensor:** Detects moisture and plays an audio alert like "Moisture Detected" while activating the buzzer.
5. **Emergency Alert:** If the user issues a voice command like "Help" using Google Assistant, a distress message with the GPS location is sent to the caregiver.

If the system loses connection, it automatically attempts to reconnect. The system runs continuously, providing real-time assistance and remote monitoring through the Ubidots platform, ensuring improved safety and mobility for the user as shown in fig.3.

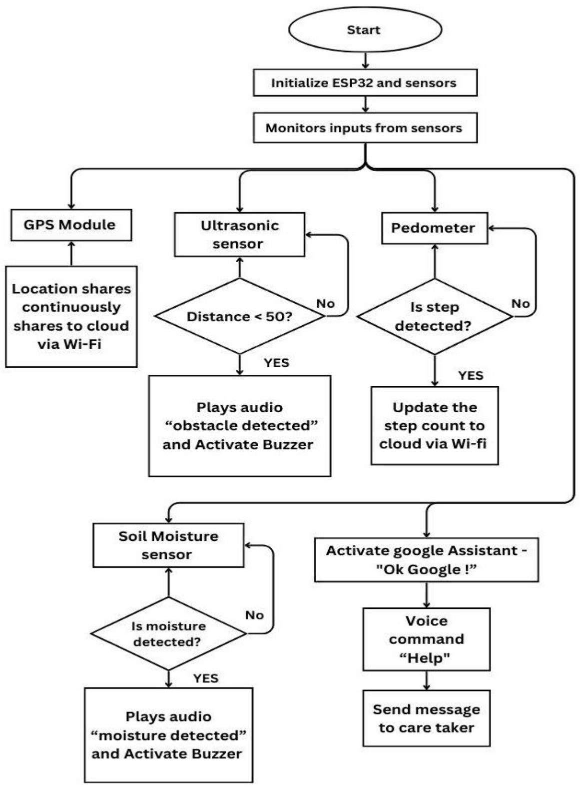

Fig.3: Workflow of Smart Shoe model

IV. RESULTS

In proposed smart shoe system offers real-time obstacle detection and alerts using ultrasonic sensors and audio feedback through the DFPlayer Mini.

The system ensures timely feedback to the user by operating in both manual and automatic modes. Improved obstacle detection algorithms and optimized sensor placement enhance the system's accuracy and response time. Performance tests were conducted using a 5Ah rechargeable battery (2x 18650 Li-ion cells in parallel) with an ultrasonic detection range of up to 2 meters.

The system achieved higher accuracy compared to previous models, as shown in Table 1. Optimized signal processing reduced obstacle detection latency to approximately 120ms, ensuring quick feedback to the user. The power consumption was minimized through low-power standby modes, extending battery life to 5–6 hours per charge. Table 2 summarizes the detection accuracy and alert system performance.

During testing, we conducted multiple trials, and the obstacle detection system performed as follows in table 1;

True Positive (TP) → The obstacle was correctly detected.

False Positive (FP) → The system incorrectly detected an obstacle when there wasn't one.

False Negative (FN) → The system missed an obstacle that was actually there.

True Negative (TN) → The system correctly identified that there was no obstacle.

Accuracy - Measures how often the system is correct in detecting obstacles.

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} X\ 100$$

Precision - Measures how many detected obstacles were actually obstacles (avoiding false alerts).

$$Precision = \frac{TP}{TP + FP} X\ 100$$

Recall (Sensitivity) - Measures how many actual obstacles were detected (avoiding missed obstacles).

$$Recall = \frac{TP}{TP + FN} X\ 100$$

F1-Score - A balance between Precision and Recall (higher is better).

$$F1 - Score = 2\ X \frac{PrecisionXRecall}{Precision + Recall}$$

Table 1: Detection Outcomes of the System

Detection Outcome	Count
True Positives (TP) → Correctly detected obstacles	49
False Positives (FP) → Mistakenly detected obstacles	2
False Negatives (FN) → Missed obstacles	1
True Negatives (TN) → Correctly identified no obstacles	48

V. CONCLUSION

The "IoT-Based and Cloud Monitoring Smart Shoe for Blind People" is an advanced assistive device designed to enhance the mobility and safety of visually impaired individuals. By integrating ultrasonic sensors and audio feedback, the system provides real-time obstacle detection with a latency of 120ms (Fig. 3), ensuring quick and accurate alerts to prevent collisions. The inclusion of a dual 18650 Li-ion battery (5Ah capacity) guarantees a battery life of 5-6 hours, making the device suitable for extended daily use without frequent recharging. This ensures reliability and convenience, essential for individuals who rely on assistive technology for independent navigation.

Beyond obstacle detection, the smart shoe incorporates a moisture detection mechanism (Fig. 4) to warn users about slippery surfaces, reducing the risk of accidental slips and falls. The integration of an emergency alert feature, activated through voice commands, allows caregivers to receive real-time GPS location updates, ensuring immediate response in case of emergencies. This IoT-based solution enables remote monitoring through the Ubidots cloud, allowing caregivers to track movement patterns, assess environmental risks, and provide timely assistance when needed.

By combining sensor-based navigation, real-time monitoring, and cloud-based analytics, this smart shoe significantly improves the safety and autonomy of visually impaired individuals. Future enhancements, such as AI-driven obstacle classification, haptic feedback, and extended battery life, could further refine the system's functionality, making it even more adaptable and user-friendly. This innovation represents a major step toward enhancing accessibility, providing a smarter, safer, and more independent walking experience for visually impaired users.

Fig.4: Obstacle Detection and Audio Feedback in Smart Shoe

Fig.5: Moisture Detection and Audio Feedback in Smart Shoe

VI. FUTURE SCOPE

Future versions of the smart shoes can be designed with improved battery efficiency and wireless charging capabilities. Enhancing the power management systems will allow for longer usage without frequent recharging, making the devices more convenient for daily use. These advancements will contribute to making the systems even more effective, accessible, and widely adopted for visually impaired individuals worldwide.

Incorporating haptic feedback along with audio alerts can provide a more intuitive response system, ensuring users receive alerts in varying environmental conditions, including noisy surroundings. The addition of IoT-based health monitoring features, such as step pattern analysis and fall detection, can further extend the smart shoe's functionality, offering real-time health insights to caregivers. Enhanced cloud integration with AI-driven analytics can provide historical movement patterns, enabling adaptive learning for personalized navigation assistance.

Future advancements may also focus on miniaturization and ergonomic improvements, ensuring the design remains lightweight, stylish, and comfortable without compromising functionality. Expanding compatibility with smart assistants and wearable devices could create a more interconnected assistive ecosystem. These developments will contribute to making the smart shoe even more effective, accessible, and widely adopted for visually impaired individuals worldwide.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

References

[1] Ariba khanam, Anuradha Dubey, Bhabya Mishara, "A Smart Assistive Shoes for Blind People", International Journal of Advance Research in Science and Engineering, Volume No.07, special issue No 2018

[2] S.D. Asha Mahesh, K.Raj Supriya, M.V.S.S.N.K. Pushpa Latha, P. Gowri, T.Sonia, B. Nani, " Smart Assistive Shoes and Cane: Solemates for the Blind People", International Journal of Engineering Science and Computing, Volume 8 Issue No.4,2018

[3] M. Madhu Meena, M.K. kadiravan, R. Kowsalya, R.J. Lokharaj, "Li-Fi Based Smart Shoe for Blind", International Journal of Engineering Science and Computing, Volume 9 Issue No.3, 2019.

[4] Roy ABI ZEID DAOU, Jeffrey CHEHADE, Georgio ABOU HAYDAR1, Ali HAYEK , and Jose Javier Serrano OLMEDO "Design and Implementation of Smart Shoes for Blind and Visually Impaired People for More Secure Movements" 2020

[5] Teja Chava, A. Tarak Srinivas, A. Lohith Sai, Venubabu Rachapudi – "IoT based Smart Shoe for the Blind" 2021

[6] Thanuja C S, Sahana M H, Sindhu G, Shruti B P– "Design of Smart Shoe for the Blind with Cordless Load" 2022

[7] Dr. K. Venkata Rao, Mohammed Ameenulla Z, Damini K Devadiga, Deepa S Rao, Gauthami N.P – "SMART SHOE FOR THE BLIND" 2023

[8] Kumar N Krishnamurthy, Akshatha M, Bhoomika S, Bindu K, Inchara I "IOT Based Smart Shoe for The Blind People" 2024

[9] Ubidots Documentation – "Getting Started with Ubidots Platform,"

[10] Google Routine – "Set Up and Use Google Assistant Routines,"