

IOT Based Smart Assistive Shoe for Blind and Elderly with Navigation, Health Monitoring, and Unpaired Device Integration

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ABSTRACT:

Visually impaired and elderly individuals face significant challenges in independent mobility and health monitoring. Traditional assistive devices like walking sticks or basic wearable trackers provide limited functionality and lack real-time emergency communication. This project presents an IoT-based Smart Assistive Shoe that integrates obstacle detection, navigation guidance, fall detection, and vital health monitoring into a single wearable system. The system uses ultrasonic sensors for obstacle detection, MPU6050 accelerometer for fall detection, respiratory and pulse oximeter sensors for health monitoring, and temperature sensors for body temperature tracking. Alerts are provided through vibration motors, buzzers, voice modules, and LCD display. In emergency situations, the system transmits real-time location and alert messages using GPS and GSM modules. Arduino and ESP32 microcontrollers manage sensor data processing and IoT communication. This system enhances personal safety, mobility assistance, and real-time health monitoring for blind and elderly users, providing an affordable and reliable smart wearable solution.

Keywords: Smart Assistive Shoe, Obstacle Detection, Fall Detection, Health Monitoring, IoT Communication

INTRODUCTION:

The proposed system is a lightweight smart glass integrated with an audio aid, designed specifically to assist visually impaired individuals in navigating their surroundings more effectively. The smart glass incorporates advanced sensor technologies and real-time processing capabilities to detect obstacles, identify objects, and recognize environmental cues. Detected information is instantly communicated to the user through an audio feedback mechanism, enabling safer and more independent mobility. The design emphasizes wearable

comfort and low power consumption, ensuring that the device is lightweight, unobtrusive, and suitable for daily use. This system aims to enhance the autonomy and quality of life for visually impaired users by providing timely, intuitive, and reliable guidance in real-world environments [1].

The proposed system, GuideCane, applies mobile robot technologies to assist visually impaired individuals in safe and independent navigation. By integrating sensors, obstacle detection algorithms, and real-time path-planning techniques, the GuideCane can detect obstacles and guide users around them efficiently. Feedback is provided through haptic or audio signals, allowing users to respond intuitively to environmental hazards. The design focuses on user safety, reliability, and ease of use, making it suitable for daily mobility. This innovative approach leverages robotic principles to enhance the autonomy and confidence of visually impaired people in navigating complex environments [2].

The proposed system is a portable 3D sound/sonar navigation device designed to assist blind individuals in safely navigating their environment. Utilizing sonar sensors, the system maps the surroundings in real time and converts spatial information into 3D auditory cues, allowing users to perceive obstacles and navigate effectively without relying on vision. The device emphasizes portability, ease of use, and low power consumption, ensuring it can be comfortably used in daily life. By providing accurate and intuitive auditory feedback, this system enhances independence, situational awareness, and mobility for visually impaired users, enabling safer movement in both familiar and unfamiliar environments [3].

The proposed system is a navigation aid for blind individuals that utilizes tactile-visual sensory substitution

to convey environmental information. By converting visual cues into tactile signals, the device enables users to perceive obstacles, pathways, and spatial layouts through touch. The system integrates sensors and real-time processing algorithms to detect obstacles and provide timely feedback, enhancing safety and navigational efficiency. Designed with ergonomics and user comfort in mind, this aid offers an intuitive and non-intrusive solution for independent mobility. The approach demonstrates how sensory substitution can effectively compensate for visual impairments, improving autonomy and confidence for visually impaired users in daily life [4].

The proposed system is a low-cost artificial vision solution designed to assist visually impaired individuals in perceiving and interacting with their surroundings. By employing affordable sensors and image-processing algorithms, the system detects obstacles, recognizes objects, and provides real-time feedback to the user through audio or haptic signals. The design prioritizes cost-effectiveness, portability, and ease of use, making advanced vision assistance accessible to a wider population. This approach aims to enhance independence, safety, and mobility, enabling visually impaired users to navigate daily environments with greater confidence and autonomy [5].

RELATED WORKS:

The proposed system is a 3D CMOS sensor-based acoustic object detection and navigation system designed to assist visually impaired individuals in safe and efficient mobility. By integrating 3D complementary metal-oxide-semiconductor (CMOS) sensors with acoustic signal processing, the system accurately detects obstacles and maps the surrounding environment in real time. The detected information is conveyed to the user through auditory feedback, enabling intuitive navigation even in complex or unfamiliar settings. Emphasizing precision, portability, and user comfort, this system offers a reliable and accessible solution to enhance independence, situational awareness, and daily mobility for blind users [6].

The proposed system is a wrist-mounted smartphone-based navigation device designed to assist visually impaired individuals using ultrasonic sensing technology. The device detects obstacles and environmental features in real time, converting the information into vibrational or auditory feedback through the smartphone, allowing users to navigate safely and independently. Its compact, wearable design ensures portability and ease of use, while

leveraging the processing power and accessibility of smartphones. This approach enhances mobility, situational awareness, and autonomy for visually impaired users, providing an affordable and practical solution for daily navigation challenges [7].

The proposed system is an IoT-based smart assistance platform designed to support visually impaired individuals in navigating and interacting with their environment. By integrating IoT sensors, real-time data processing, and wireless communication, the system can detect obstacles, identify objects, and provide timely audio or haptic feedback to the user. Emphasizing portability, affordability, and ease of use, this smart assistance solution enables enhanced mobility, safety, and independence for visually impaired users. The approach demonstrates how connected technologies can effectively improve daily life and accessibility for people with visual impairments [8].

The proposed system provides obstacle detection and navigation support for visually impaired individuals using SMART technology. By employing advanced sensors and real-time processing algorithms, the system identifies obstacles and environmental hazards, delivering audio or haptic feedback to guide the user safely. Designed with portability, user comfort, and reliability in mind, this technology enhances mobility, situational awareness, and independence, offering a practical solution to improve the daily navigation experience for visually impaired users [9].

The proposed system is an IoT-BLE based indoor navigation solution designed to assist visually impaired individuals in safely moving through indoor environments. By integrating Bluetooth Low Energy (BLE) beacons, IoT sensors, and real-time data processing, the system provides accurate location tracking and detects obstacles, delivering audio or haptic guidance to the user. Emphasizing affordability, ease of use, and reliability, this approach enhances independence, situational awareness, and mobility within complex indoor spaces, offering a practical solution for everyday navigation challenges faced by visually impaired people [10].

The proposed system is a real-time assistive shoe for visually impaired individuals, utilizing IoT-based technologies to enhance mobility and safety. Equipped with sensors embedded in the shoe, the system detects obstacles, changes in terrain, and environmental hazards, providing immediate audio or haptic feedback to the user.

The design emphasizes portability, comfort, and real-time responsiveness, enabling users to navigate their surroundings independently. This innovative approach leverages IoT connectivity to improve situational awareness, confidence, and daily mobility for visually impaired people [11].

The proposed system is a smart navigation assistance platform designed to support visually impaired individuals in safely navigating their environment. By integrating advanced sensors, real-time processing, and feedback mechanisms such as audio or haptic alerts, the system detects obstacles, identifies pathways, and provides intuitive guidance to the user. Emphasizing portability, reliability, and user comfort, this smart navigation system enhances mobility, situational awareness, and independence, offering a practical and effective solution for daily navigation challenges faced by visually impaired people [12].

The proposed system is an intelligent IoT-based smart stick designed for visually impaired individuals, incorporating image sensing technology to enhance navigation and safety. The device captures real-time visual data to detect obstacles, recognize objects, and identify environmental hazards, transmitting this information through audio or haptic feedback to guide the user. Emphasizing portability, ease of use, and connectivity, the smart stick leverages IoT capabilities to provide continuous monitoring and situational awareness, thereby improving mobility, independence, and confidence for visually impaired users in daily life [13].

The proposed system is a real-time navigation aid for visually impaired individuals, implemented through smart glasses. Equipped with advanced sensors and image-processing algorithms, the system detects obstacles, recognizes objects, and interprets environmental information, providing immediate audio or haptic feedback to the user. Designed for comfort, portability, and continuous operation, the smart glasses enhance mobility, situational awareness, and independence, offering a practical solution for safe navigation in both familiar and unfamiliar environments [14].

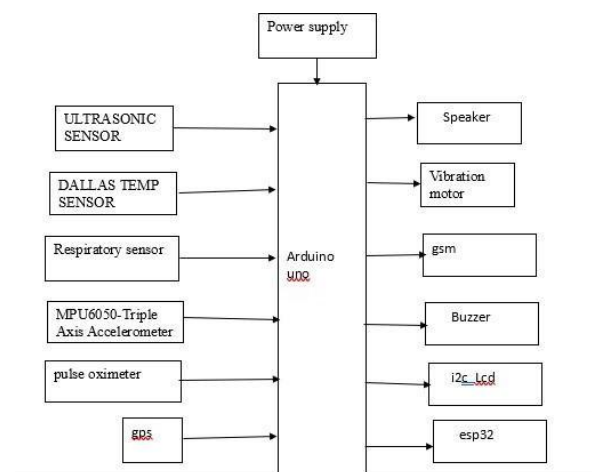
The proposed system is a smart cane designed to assist visually impaired users in safe and independent navigation. By integrating sensors and real-time processing, the cane can detect obstacles, changes in terrain, and environmental hazards, providing audio or haptic feedback to alert the user. Emphasizing portability, ease of use, and reliability, this smart cane enhances

mobility, situational awareness, and confidence, offering an effective and practical tool for daily navigation challenges faced by visually impaired individuals [15].

PROPOSED METHOD

The proposed IoT-Based Smart Assistive Shoe integrates navigation assistance, health monitoring, fall detection, and emergency communication into a single wearable system. Ultrasonic sensors detect obstacles and provide voice and vibration feedback to guide the user. Health monitoring sensors measure respiratory activity, heart rate, SpO₂, and body temperature continuously. The MPU6050 accelerometer identifies falls or abnormal posture conditions. In case of emergencies, the GPS module retrieves real-time location and the GSM module sends alert messages to caregivers. Arduino and ESP32 controllers manage sensor interfacing and IoT connectivity, ensuring reliable real-time operation. This integrated model offers enhanced safety, independence, and healthcare support.

Block Diagram:



The system is an IoT-based smart assistive device controlled by an Arduino Uno microcontroller, designed to monitor environmental and health parameters while providing real-time alerts. The device integrates multiple sensors, including an ultrasonic sensor for obstacle detection, a Dallas temperature sensor for monitoring ambient temperature, a respiratory sensor to track breathing, an MPU6050 triple-axis accelerometer for motion and fall detection, a pulse oximeter for heart rate and oxygen saturation monitoring, and a GPS module for location tracking. The Arduino processes inputs from

these sensors and triggers output devices accordingly: a speaker and vibration motor for tactile and audio alerts, a buzzer for immediate notifications, an I2C LCD for displaying real-time data, and GSM and ESP32 modules for wireless communication and remote monitoring. The system is powered through a dedicated power supply, ensuring continuous operation of the sensors and actuators. This integrated approach enables enhanced safety, mobility, and health monitoring for users in real time.

Methodology

Principle of Functioning:

The proposed IoT-based Smart Assistive Shoe operates using Arduino and ESP32 microcontrollers to provide real-time mobility assistance and health monitoring for visually impaired and elderly users. The system continuously gathers environmental and physiological data through ultrasonic sensors for obstacle detection, an MPU6050 accelerometer for fall detection, pulse oximeter and respiratory sensors for vital health monitoring, and temperature sensors for body temperature tracking. The microcontrollers constantly process these data streams, and if abnormal conditions such as nearby obstacles, sudden falls, irregular vital signs, or abnormal temperature are detected, immediate alerts are triggered. Vibration motors, buzzers, and voice modules provide haptic and audio feedback, while an LCD displays real-time health and environmental information. GPS and GSM modules transmit location and emergency alerts to authorized contacts, ensuring rapid assistance and enhanced safety.

Hardware & Alerts:

The system hardware includes ultrasonic sensors, an MPU6050 accelerometer, pulse oximeter and respiratory sensors, temperature sensors, vibration motors, buzzers, voice modules, I2C LCD, GPS module, GSM module, Arduino Uno, and ESP32 microcontrollers. Sensor data is continuously monitored and processed, and alerts are automatically issued without manual intervention. Ultrasonic sensors provide real-time obstacle detection, while the accelerometer detects falls. The vital signs sensors monitor heart rate, oxygen saturation, respiratory rate, and body temperature. Alerts are conveyed through vibration, audio signals, and LCD messages, while GPS and GSM modules send real-time emergency notifications to caregivers. This integrated hardware setup ensures a reliable, scalable, and responsive wearable system suitable for independent mobility and health monitoring.

Power Requirements:

The prototype is powered using a stable 5V supply to maintain uninterrupted operation of the microcontrollers, sensors, alert modules, GPS, and GSM units. Efficient power management ensures continuous monitoring, rapid alerting, and reliable data transmission with minimal energy consumption. Lightweight and low-power design makes the Smart Assistive Shoe suitable for extended daily use by visually impaired and elderly users.

Performance Comparison Table:

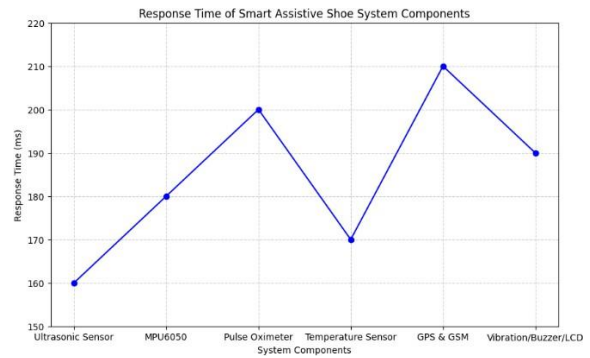
Parameter	Specification / Metric	Description
Central Controller	Arduino Uno & ESP32	Acts as the primary processing units, continuously monitoring sensor inputs, processing data, and managing communication with alert and IoT modules.
Obstacle Detection Sensor	Ultrasonic Sensor	Detects nearby obstacles in the walking path of visually impaired users to prevent collisions.
Fall Detection Sensor	MPU6050 Accelerometer	Monitors sudden movements or impacts to detect falls and trigger emergency alerts.
Vital Health Monitoring	Pulse Oximeter & Respiratory Sensor	Measures heart rate, oxygen saturation, and respiratory rate for real-time health monitoring.

Temperature Monitoring	Body Temperature Sensor	Tracks body temperature to detect abnormalities and potential health risks.
Alert & Feedback Modules	Vibration Motors, Buzzer, Voice Module, I2C LCD	Provides haptic, audio, and visual feedback to notify users of obstacles, falls, or health alerts.
Location Tracking	GPS Module	Determines real-time location of the user for emergency response.

Table 1 Performance Comparison Table

The proposed IoT-based Smart Assistive Shoe integrates multiple sensors and modules to enhance the safety, mobility, and health monitoring of visually impaired and elderly users. The system is managed by Arduino Uno and ESP32 microcontrollers, which continuously process inputs from all sensors and control the alert and communication modules. Ultrasonic sensors detect obstacles in real time, helping prevent collisions during movement. An MPU6050 accelerometer monitors sudden movements or impacts, enabling rapid fall detection and triggering emergency alerts when needed. Vital health parameters such as heart rate, oxygen saturation, and respiratory rate are measured using pulse oximeter and respiratory sensors, while body temperature is tracked using dedicated temperature sensors to detect abnormalities. The system provides immediate feedback to the user through vibration motors, buzzers, voice modules, and an I2C LCD, conveying alerts related to obstacles, falls, or abnormal health conditions. Additionally, a GPS module determines the user's location, and the GSM module transmits real-time alerts, including health and location data, to authorized caregivers or family members. This integrated setup ensures a reliable, low-power, and scalable solution for independent mobility and real-time health monitoring, providing safety and peace of mind to visually impaired and elderly individuals.

Reaction time of the system components



Graph 1: Reaction time of system components

X-axis: Hardware Modules

Y-axis: Response Time (s)

Table 1: Comparative Analysis of Conventional Techniques and the Developed Approach

Parameter	Existing Methods	Proposed Approach (Our System)
Sensor Data Collection	Basic walking sticks or wearable devices with limited sensors, no real-time data collection	Ultrasonic, MPU6050, pulse oximeter, respiratory, and temperature sensors continuously collect real-time data and send it to Arduino/ESP32 microcontrollers
Data Monitoring	Periodic manual checks or user observation	Microcontrollers automatically process incoming sensor data to detect obstacles, falls, and abnormal health parameters
Alert Triggering	Manual alerts or simple vibration/visual indicators	Vibration motors, buzzers, voice modules, and LCD display provide

		immediate feedback, while GPS and GSM modules transmit emergency alerts to caregivers in real time
Emergency Response	User-dependent or delayed intervention	Automatic notification to authorized personnel with real-time location and health data, enabling rapid assistance
Communication & Tracking	Limited or no location tracking, short-range communication	GPS provides real-time location tracking, and GSM module ensures long-range, reliable emergency communication

Table 2 Existing mobility aids and wearable devices for visually impaired and elderly individuals often rely on basic sensors or manual observation, providing limited real-time monitoring and delayed alerts. In contrast, the proposed Smart Assistive Shoe integrates ultrasonic sensors, an MPU6050 accelerometer, pulse oximeter, respiratory sensors, and temperature sensors to continuously collect real-time data, which is processed by Arduino and ESP32 microcontrollers. This allows for automatic detection of obstacles, falls, and abnormal health parameters without manual intervention. Alerts are provided instantly through vibration motors, buzzers, voice modules, and an LCD display, while GPS and GSM modules transmit emergency notifications with real-time location and health information to authorized caregivers. This approach ensures timely assistance, improves user safety, and overcomes the limitations of traditional methods, offering a reliable, low-power, and scalable solution for independent mobility and health monitoring.

RESULTS



FIG1-Smart Shoe with Health and Safety Sensors

Fig1-The image shows a wearable smart shoe prototype integrating multiple sensors and a central microcontroller for real-time monitoring. The left shoe has a buzzer for alerts, while the right shoe features an ultrasonic sensor for obstacle detection. Both shoes are connected to a central board with an LCD display for immediate feedback. The system demonstrates a mobile IoT solution for health tracking, environmental sensing, and personal safety, highlighting its potential applications for assistive technology and real-time alerts.

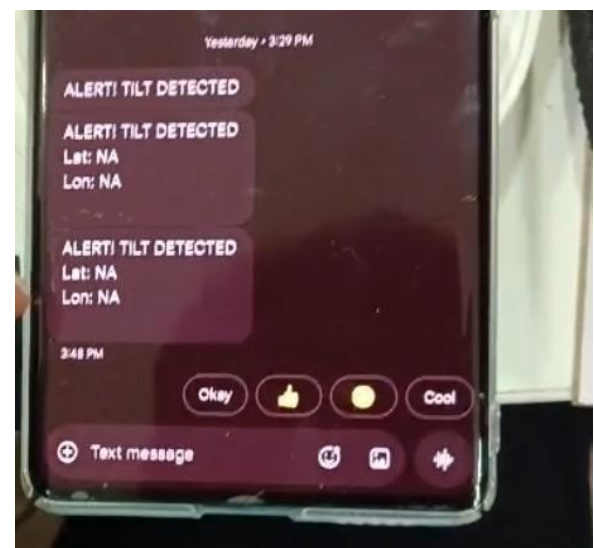


FIG2-Real-time alert notifications received on a mobile device from the smart shoe system

Fig2-The image shows a mobile phone screen displaying

multiple alert messages generated by the smart shoe system. Each notification indicates a tilt detection event, signaling a potential fall or sudden change in foot orientation. While the exact latitude and longitude values are not available, the alerts demonstrate the system’s ability to instantly communicate critical events to a remote device, enabling timely intervention. This feature highlights the wearable system’s application in personal safety, fall detection, and real-time monitoring for healthcare or assistive technology purposes.

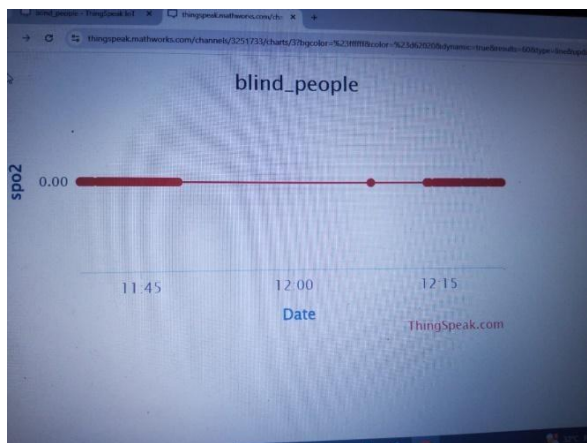


FIG3-Sensor Data Visualization for Blind People Monitoring

Fig3-The image shows a line graph displayed on a digital platform, representing data collected over a specific time period. The graph is labeled “blind_people” and appears to track a variable recorded at different time intervals. The horizontal axis represents time, with markers around late morning to early afternoon, while the vertical axis shows measured values, which remain close to zero throughout the duration. A red line connects multiple data points, indicating minimal fluctuation with a few slight changes at certain times. Overall, the visualization suggests that the monitored parameter stayed relatively stable during the observed period.

CONCLUSION

The IoT-Based Smart Assistive Shoe provides a comprehensive solution for navigation assistance, health monitoring, and emergency communication for blind and elderly individuals. By integrating multiple sensors with IoT connectivity, the system ensures independent mobility, continuous health supervision, and rapid emergency response. The proposed model overcomes

limitations of traditional assistive devices by offering a compact, wearable, and intelligent safety solution. Future enhancements may include AI-based voice navigation, smartphone app integration, and cloud-based data analytics for long-term health tracking.

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