SMART SHOE FOR VISUALLY DISABLED INDIVIDUALS WITH OBJECT DETECTION AND PIT DETECTION

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Keywords:

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Introduction:

Mobility is a key component of personal independence, yet it remains a persistent challenge for individuals with visual and hearing impairments. Traditional aids like the white cane or stick provide limited support, primarily detecting obstacles at ground level. However, they often fail to identify pits, uneven terrains, or elevated hazards, which can compromise user safety and confidence—especially in unfamiliar or hazardous environments. To overcome these limitations, this project introduces an innovative solution: Smart Assistive Shoes that complement the conventional stick by incorporating advanced sensor-based technology. Designed specifically for the visually and hearing-impaired, these smart shoes integrate an Arduino Nano microcontroller, ultrasonic sensors, a GPS-GSM module, a buzzer, and a vibration motor. The ultrasonic sensors provide real-time detection of obstacles and pits, delivering immediate feedback through both auditory (buzzer) and tactile (vibration) alerts. This dual feedback system ensures usability for individuals with combined sensory impairments. Additionally, the GPS-GSM module enables real-time location tracking and emergency alerts, enhancing safety during unexpected situations. Unlike traditional aids, the smart shoes also detect uneven terrain and sudden environmental changes caused by natural calamities, making them highly adaptable across diverse geographical conditions. By combining real-time navigation support with emergency communication and terrain adaptability, this project aims to significantly improve the autonomy, safety, and quality of life for differently abled individuals. The Smart Assistive Shoes, used alongside a stick, provide a more holistic and intelligent mobility aid, redefining the future of assistive wearable technology.

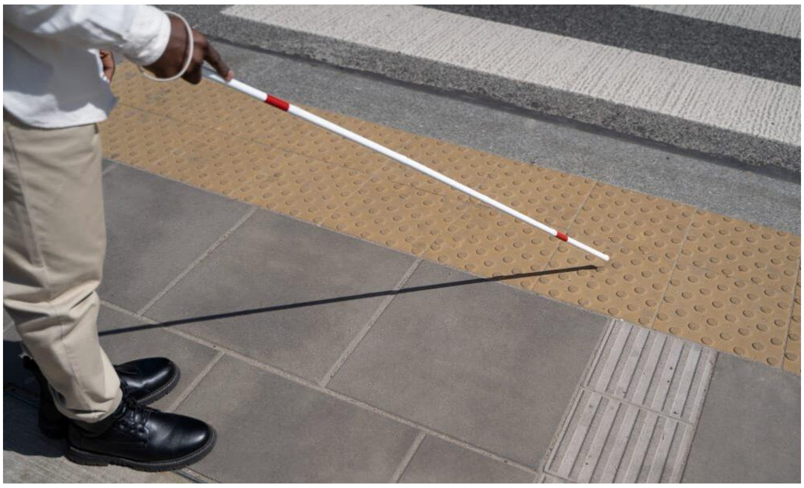

Figure 1(a): Visually impaired individual using Stick

Objectives:

1. Develop smart shoes with sensors for real-time obstacle and pit detection.
2. Integrate auditory (buzzer) and tactile (vibration motor) feedback for accessibility.

3. Implement GPS-GSM modules for location tracking and emergency alerts.
4. Enhance terrain adaptability for diverse environments and natural calamities.
5. Design a lightweight, cost-effective, and user-friendly wearable device.
6. Ensure quick response mechanisms for emergencies like disorientation or accidents.

Methodology:

The proposed system begins with selecting key components such as the Arduino Nano, ultrasonic sensors, a buzzer, vibration motor, GPS, and GSM modules. Ultrasonic sensors are employed for detecting obstacles and pits in the user's path. The Arduino Nano is programmed to trigger both a buzzer and a vibration motor to provide immediate feedback upon obstacle detection. Additionally, a GPS module is integrated to enable real-time location tracking, while the GSM module is used to send emergency alerts when necessary. Finally, the system is tested across different environments to ensure its reliability and functionality under various conditions.

Result and Conclusion:

The smart shoe system was successfully developed and tested, integrating all key components including the Arduino Nano, ultrasonic sensors, buzzer, vibration motor, GPS, and GSM modules. During testing, the ultrasonic sensors accurately detected both static and dynamic obstacles, as well as pits and uneven surfaces, at varying distances and angles. The Arduino was effectively programmed to respond to these detections by activating a buzzer and a vibration motor, offering immediate auditory and tactile feedback. This dual feedback mechanism proved essential, especially for users with hearing impairments, ensuring alerts were perceived in all conditions.

The GPS module provided real-time location tracking with reasonable accuracy, while the GSM module reliably sent emergency alert messages to a pre-set contact number, including the user's coordinates. The system was tested in both indoor and outdoor environments, including areas with stairs, slopes, and rough terrain. It showed consistent performance, minimal false positives, and durable operation under different lighting and weather conditions.

Moreover, the entire setup was compact and lightweight, allowing it to be embedded into footwear without causing discomfort. The prototype was also cost-effective, using readily available components, which supports its scalability and accessibility for widespread use among the target population.

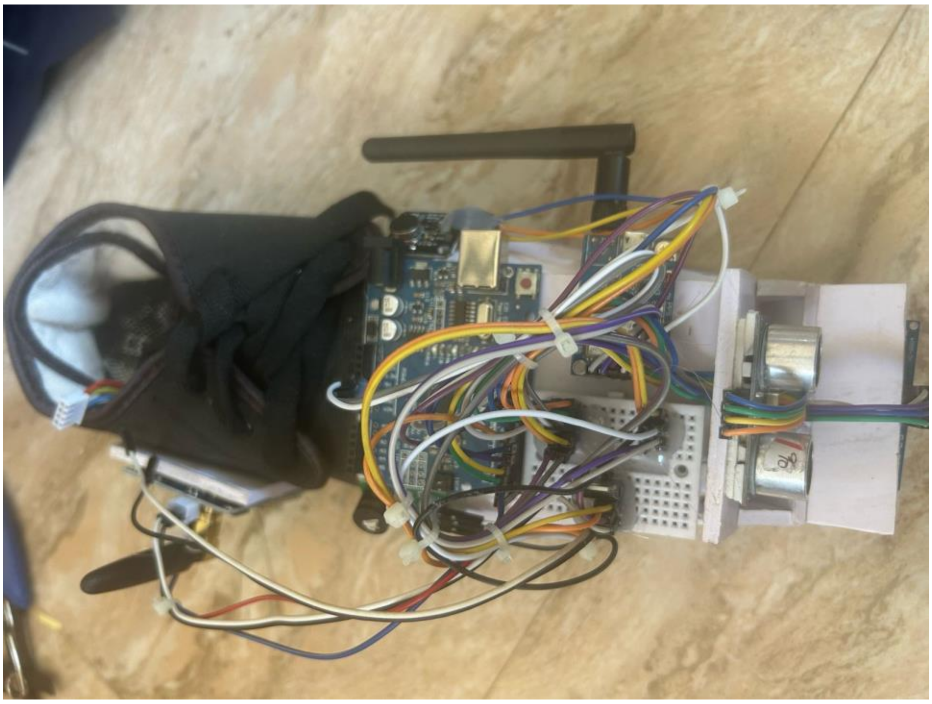

Figure 2(a): Top View of the Project model

Future Scope:

The future scope of this project includes:

1. Integration of rechargeable battery systems to enhance portability and ease of use.
2. Addition of Bluetooth or Wi-Fi connectivity for pairing with smartphones and cloud-based tracking.

3. Implementation of AI-based terrain recognition for advanced obstacle classification and response.
4. Development of a dedicated mobile app for real-time monitoring, route guidance, and system customization.
5. Enhancing water resistance and durability to make the shoe suitable for all-weather and rough outdoor conditions.