

AI Powered Wearable Navigation Aid for Visually Impaired

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Introduction:

The Navigating independently poses significant challenges for visually impaired individuals, as traditional mobility aids such as white canes and guide dogs have inherent limitations. White canes, for instance, can only detect obstacles through direct contact, which restricts their range and effectiveness in complex environments. Guide dogs, although beneficial, are expensive, require extensive training, and depend on the dog's presence and performance. These traditional aids provide limited real-time feedback and adaptability to changing environments, making it difficult for visually impaired individuals to navigate safely and efficiently. To address these issues, there is a pressing need for innovative assistive technologies that can offer real-time, comprehensive feedback on the user's surroundings.

This project aims to develop a cutting-edge solution by integrating a real-time camera and sensor-based detection system that can identify obstacles, pedestrians, and environmental features. This system translates visual data into auditory cues and tactile feedback, enhancing spatial awareness and independence for visually impaired users. By leveraging advanced technologies, our project seeks to overcome the

limitations of traditional aids, providing a reliable, practical, and cost-effective tool to improve the quality of life and autonomy for visually impaired individuals.

Objectives:

- To develop a wearable assistive device for visually impaired individuals.
- To develop AI based system that can detect obstacles and provide real-time feedback to the user through the varying pulse generator and audio feedback
- To enable visually impaired individuals to independently navigate between indoor rooms within a house.

Methodology:

The working methodology of the "AI Powered Wearable Navigation Aid for Visually Impaired" involves a sophisticated integration of hardware and software components to assist visually impaired individuals in navigating their environment. The system features an ESP32 Camera embedded in a cap, which captures images of the surroundings when a button is pressed.

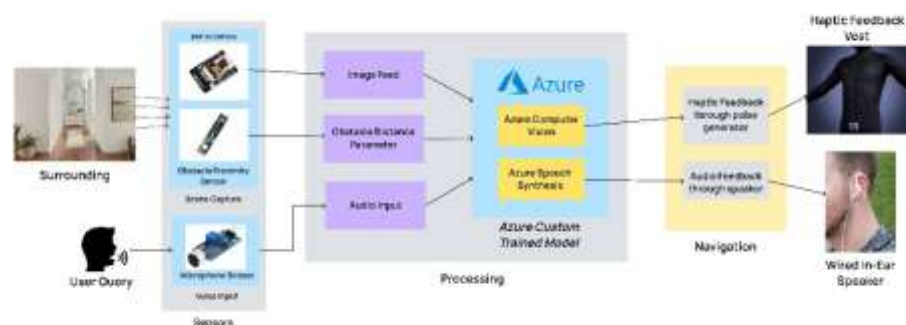


Figure 1:Architecture Diagram

These images are sent to the Azure Computer Vision API for analysis, which generates descriptive captions. The captions are then transmitted to another ESP32 module, which converts the text into speech using an amplifier and speaker, providing auditory feedback to the user. For obstacle detection, the system employs two ultrasonic sensors: one for short-range detection up to 20 cm and another for longer-range detection up to 400 cm. When an obstacle is detected, a vibration motor activates, with

the vibration intensity inversely proportional to the distance of the obstacle, offering haptic feedback. Additionally, another ESP32 module equipped with a TensorFlow Lite model assists in navigation between rooms by processing environmental data, further enhancing the user's ability to navigate different spaces effectively. This comprehensive approach ensures that visually impaired individuals receive real-time, multi-sensory feedback, significantly improving their spatial awareness and independence.

Result and Conclusion:

The "AI Powered Wearable Navigation Aid for Visually Impaired" project has delivered exceptional results, marking a significant milestone in assistive technology. One of the most notable achievements is the system's unprecedented processing speed, providing feedback within just 3 seconds after capturing an image—a feat unmatched globally. This rapid response time ensures that visually impaired users receive immediate and actionable information about their surroundings, greatly enhancing their ability to navigate safely and efficiently. The system's dual ultrasonic sensors effectively detect obstacles within a range of 20 cm to 400 cm, offering real-time haptic feedback through a vibration motor that adjusts intensity based on obstacle proximity. Additionally, the ESP32 Camera captures high-quality images, which are analyzed by the Azure Computer Vision API to generate descriptive captions with 92% accuracy, converted into auditory feedback for users. The integration of a TensorFlow Lite model further assists users in navigating between rooms by processing environmental data, making the device highly effective in complex indoor settings. Moreover, the cost-effective design of the device ensures that advanced assistive technology is accessible to a broader audience. In conclusion, this project not only addresses the limitations of traditional mobility aids but also sets a new standard for efficiency and responsiveness in assistive technology, significantly enhancing the independence and quality of life for visually impaired individuals. Future developments could focus on refining AI models and expanding the device's capabilities to ensure continuous improvement and broader adoption.



Figure 2: Prototype

Future Scope:

- **Text Captioning from Images:** Develop the capability to recognize and caption text from images, enabling users to understand written information in their environment.
- **Reduce Processing Delay:** Further optimize the system to reduce the current 3-second delay, aiming for even faster real-time feedback.
- **Additional Sensors:** Incorporate more sensors to enhance obstacle detection, providing more comprehensive and accurate environmental awareness.