Pathfinder

A NAVIGATION GUIDE FOR VISUALLY IMPAIRED USERS

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PROBLEM STATEMENT

1. Visually impaired individuals struggle to navigate unfamiliar and dynamic environments, especially real-time obstacles like stairs, potholes, uneven terrain, or moving objects. Existing navigation and assistive tools focus on route-level guidance or static infrastructure, offering limited real-time awareness and reduced effectiveness in outdoor or crowded settings.

2. We propose a wearable navigation system (Ex. vest attachment) that combines computer vision, GPS navigation, and audio feedback to safely guide visually impaired users. The system uses real-time camera input to detect obstacles and hazards while providing context-aware audio alerts and turn-by-turn directions.

METHODOLOGY

We aim to design our tech stack using the following elements.

1. ML models (Ex. tinyML to run on a mobile device)
2. Hardware sensors (Ex. camera and mic)
3. Maps (for routing outdoors)
4. Communication interface (between sensors and model)
5. Audio processing pipeline

METHODOLOGY

Input

Collect real-time data using cameras and microphones embedded on a wearable on the body.

Data Processing

Use the collected data to determine location (for route navigation) and surrounding objects (for alert system).

Navigation

Use inferred location for further navigation in outdoor settings.

Identify Issues

Use collected camera data to estimate distance from potential threats such as obstruction or uneven terrain.

Output

Audio-based alerts and navigation mechanisms for route guidance as well as immediate action for obstructions or moving objects.

EVALUATION

Literature Review

Define key mobility challenges and accessibility gaps in real-world navigation for visually impaired users by conducting a literature review to identify pain points.

Participants Survey

Survey visually impaired users where possible.
We may have to supplement in-person surveys with other users and/or accessibility experts in online format.

Real-world Testing

Conduct real-world walk observations to surface potential issues.

Simulated Environment

Simulate audio alerts and navigation cues to evaluate timing, clarity, and cognitive load.

A/B Testing of the device

Compare against existing navigation and assistive software using A/B testing.

KEY FEATURES

Real-time Obstacle Detection

- Detects obstacles such as pedestrians, vehicles, poles, walls, and stairs
- Identifies dangerous terrain like potholes, uneven surfaces, or open drains

Environmental Awareness

- Alerts users about approaching hazards (Ex. low-hanging objects, crowded zones)
- Distance-based warnings (Ex. “Obstacle 2 meters ahead”)

Navigation Assistance

- GPS-based route guidance to a specified destination
- Audio-based turn-by-turn instructions

Hands-free Interaction

- Audio input/output for commands and feedback

THE NOVELTY OF OUR PROJECT

Accessibility-First Design

Avoids reliance on LiDAR, which is limited to high-end devices (Ex. iPhone Pro models) and restricted APIs. Uses standard RGB cameras, making the system affordable and widely deployable.

Context-Aware Alerts

Prioritizes critical obstacles and hazards to reduce cognitive overload and improve usability for visually impaired users.

Modular Wearable Adaptability

Designed to work across multiple form factors (wearable can be clipped onto any clothing or held as comfortable), allowing sensor placement to adapt to different mobility needs and environments.

Hybrid Intelligence

Combines map-based navigation (macro guidance) with real-time vision-based hazard detection (micro safety).

SCOPE FOR FUTURE WORK

Future work to enhance this system may include the following measures:

1. Include additional sensing modalities to improve robustness across diverse lighting, weather, and crowd conditions.

2. Develop user-specific feedback to tailor alerts based on individual preferences, mobility patterns, and contextual needs.

3. Conduct longitudinal user studies to assess user retention, system usability, reliability, and impact across varied indoor and outdoor environments.

Thank you!

Have a question?

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