PROBLEM STATEMENT

Visually impaired individuals navigating indoor environments often rely on assistive technologies that announce detected objects. However, object identification alone does not indicate whether an obstacle lies directly in the walking path or requires an immediate change in movement.

For example, hearing “chair detected” does not inform the user whether they are about to collide with it or can safely continue forward.
This project focuses on enabling action-oriented indoor navigation assistance by converting visual perception into movement guidance rather than descriptive awareness.

The proposed system will operate within a controlled indoor environment and focus specifically on two risks: (1) obstacle collision and (2) blocked walking path within a near-field range of 0–3 meters. Using a webcam as a proof-of-concept input, the system will perform real-time object detection and monocular depth estimation. A rule-based risk assessment module will determine potential collision danger based on object distance and overlap with a predefined walking zone. The walking zone is defined as the central region of the camera frame corresponding to the user’s forward movement path.

If an obstacle occupies this zone within a critical distance threshold, it is classified as a collision risk. A collision is defined as any physical contact between the participant and an obstacle during navigation. If the walking zone is obstructed, the system will evaluate lateral zones to identify a safer direction and generate concise navigation prompts such as “move left” or “move right”.

The reasoning mechanism will be explicitly rule-driven using spatial thresholds such as object proximity and path overlap, ensuring interpretability and feasibility within the project timeline. To evaluate effectiveness, the system will be compared against a baseline system that uses the same detection and depth estimation models but outputs only object names without navigation guidance.

Performance will be assessed using a fixed indoor obstacle course with blindfolded participants. Each participant will perform multiple repeated trials under both system modes to reduce randomness, with a minimum of 5 participants and at least 3 trials per participant.

Measured metrics will include:

- Collision count
- Navigation completion time
- Number of corrective stops (full halt ≥ 3 seconds, step back, or manual intervention)
- Reaction time (measured as the time between delivery of an audio instruction and the user initiating movement in response)

Since system response time cannot be predetermined prior to implementation, latency will be treated as a usability-driven requirement to be measured and validated during testing. The system must satisfy two acceptance criteria: (1) navigation guidance must allow the participant to react without stopping abruptly, and (2) the participant should be able to walk continuously without frequent stops caused by delayed feedback. End-to-end response time will therefore be measured from the moment an obstacle enters the walking zone to the delivery of the corresponding audio instruction. Observed latency will be evaluated relative to user performance during navigation trials to determine whether it supports safe and uninterrupted movement.

The system will be designed for offline execution and evaluated using a webcam-based proof-of-concept setup with audio feedback delivered through earphones.

The objective is to evaluate improvement in safe indoor mobility when visual perception is translated into actionable navigation guidance rather than simple object announcements.

TEAM DETAILS

Group Number: 4
# of Members: 5
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