Proof of Concept

Smart Glasses for Visually Impaired Individuals

1. Executive Summary

This Proof of Concept (POC) seeks to demonstrate the feasibility of smart glasses designed to assist visually impaired individuals by integrating real-time object detection, navigation guidance, and voice feedback. The glasses utilize a combination of a camera module, Raspberry Pi, and 3D-printed frames to form the hardware, while Python-based software powers the detection and feedback system.

During initial prototyping, the Raspberry Pi overheated, leading to system instability. This POC aims to resolve the overheating issue, refine software performance, and validate functionality in controlled environments. By focusing on usability and technical robustness, this project addresses the lack of accurate, adaptable assistive devices for blind and visually impaired individuals.

2. Objectives and Scope

Objectives:

1. To resolve hardware issues, particularly the Raspberry Pi overheating, ensuring stable performance.
2. To validate the functionality of object detection and voice feedback under indoor conditions.
3. To collect user feedback from visually impaired individuals to assess usability and identify improvement areas.

Scope:

- This POC focuses on testing the device’s ability to detect obstacles, provide real-time voice feedback, and operate without overheating in controlled indoor environments.

- It does not address extended battery life, outdoor performance, or integration with advanced navigation systems at this stage.

3. Problem Statement

Globally, over 250 million people face visual impairments, many of whom lack access to reliable assistive technologies. Current devices have limitations, including narrow fields of view, inadequate obstacle detection ranges, and ineffective navigation systems. These limitations reduce their practicality in real-world scenarios. The proposed smart glasses aim to tackle these shortcomings, offering an innovative, user-friendly device that improves mobility and independence for visually impaired individuals.

4. Approach and Methodology

The POC will be executed in three phases:

Phase 1: Hardware Refinement

- Address the overheating issue of the Raspberry Pi:
  - Install heat sinks and cooling fans.
  - Explore alternative microcontrollers (e.g., Jetson Nano or Arduino) if overheating persists.
- Assemble components into 3D-printed frames for testing.
- Ensure ergonomic design and alignment of the camera module for optimal obstacle detection.

Phase 2: Software Development

- Debug and optimize the existing Python code for object detection:
  - Use TensorFlow and OpenCV to enhance obstacle recognition accuracy.
  - Train the detection algorithm with diverse datasets to handle varying object sizes and distances.
- Refine the text-to-speech (TTS) system for clear, concise, and real-time voice feedback.
- Integrate all modules into a single system.

Phase 3: Testing and User Validation

- Conduct controlled tests in indoor environments:
  - Use obstacle courses with furniture, walls, and small objects.
  - Measure detection accuracy, processing speed, and voice feedback latency.
- Involve three visually impaired users in usability testing:
  - Record their feedback on comfort, functionality, and responsiveness.
  - Use this feedback to identify areas for improvement.

5. Resources Required

Hardware:

- 1 Raspberry Pi 4B (or equivalent alternative)
- Camera module
- Speaker
- 3D-printed frames
- Heat sink and cooling fan
- Power bank for portable use

Software:

- Python programming environment
- TensorFlow and OpenCV for machine learning and computer vision
- pyttsx3 or similar TTS library for voice feedback

Team Members and Roles:

1. **Hardware Specialist:** Resolves overheating and ensures assembly integrity.
2. **Software Developer:** Refines object detection and TTS integration.
3. **User Testing Coordinator:** Designs test scenarios and collects user feedback.
4. **Documentation Specialist:** Prepares reports and oversees progress tracking.

6. Success Criteria

The success of this POC will be measured against the following criteria:

1. **Hardware Performance:**
    - The system operates for 1 hour without overheating.
2. **Software Accuracy:**
    - Object detection achieves >85% accuracy for common obstacles (e.g., furniture, walls).
    - Audio feedback latency is <1 second.
3. **User Feedback:**
    - At least 2 out of 3 visually impaired users report positive experiences regarding usability and functionality.

7. Expected Outcome

By the end of the POC, we expect:

1. A stable prototype capable of detecting obstacles and delivering timely audio feedback.
2. A resolved overheating issue, ensuring longer operational stability.
3. Actionable user feedback to guide further development.
4. A validated foundation for expanding the glasses' capabilities, such as GPS navigation or outdoor usage.

8. Risks and Challenges

1. **Raspberry Pi Overheating:**
    - **Mitigation:** Install a heat sink and fan or switch to a more efficient microcontroller.
2. **Low Detection Accuracy in Complex Environments:**
    - **Mitigation:** Use additional training datasets and refine the algorithm.
3. **Audio Feedback Latency:**

- **Mitigation:** Optimize the codebase to reduce processing delays.

4. **User Comfort Issues:**
    - **Mitigation:** Gather user feedback on the 3D-printed frame design and adjust accordingly.

9. Conclusion

This POC will validate the technical and functional feasibility of smart glasses for visually impaired individuals. Addressing hardware overheating and refining the software will result in a stable and effective prototype. User testing will provide valuable insights into improving comfort and usability, creating a strong foundation for future iterations and commercialization.