Design Proposal for AI-Integrated Vision Glasses

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1. Project Overview

This proposal outlines the design of an affordable, AI-integrated vision glasses system intended for visually impaired and blind users. It will combine camera-based object recognition with real-time audio feedback using artificial intelligence technology. The system will provide users with key information about their surroundings in a grocery store environment—including item identification, pricing, and navigation—which can enhance independence of visually impaired customers. This targets a relatively large underrepresented demographic of customers, largely being those in the older population, who have trouble reading fine print on products inside stores, locating signs and associated isles within the stores, and other general navigation ability due to visual impediments.

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We are still working on finding a faculty/industry mentor.

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2. Objectives

1. **Assistive Vision**: Help visually impaired users access important visual information about products, environments, and navigation.
2. **Affordability & Accessibility**: Keep hardware costs low by leveraging readily available microcomputers and open-source software while narrowing use cases, contrasting with other existing augmented reality smart glasses targeted for general consumers (Apple Vision, Meta)
3. **Practical Prototyping**: Develop a working prototype that demonstrates the feasibility of the concept in a real-world setting.

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3. Proposed System Architecture

Hardware Components

- **Camera Module**: Captures real-time images for analysis.
- **Processor (e.g., Raspberry Pi)**: Serves as the local computing unit, handling input/output operations and networking to the image processing machine learning model in the cloud.
- **Speaker/Audio Module**: Provides audio feedback to the user, announcing item details and other relevant information.

- **Button**: Initiates image capture and particular product selection when pressed, reducing power usage and preventing accidental captures.
- **Glasses Frame**: Holds the camera and other lightweight components in a wearable format; can be 3D-printed to reduce costs
  - *ALTERNATIVELY:* A clip-on accessory to existing glasses frames for users who have prescription glasses
- **Battery/Power Supply**: Supplies power to the Pi, camera, and speakers for portable, on-the-go use.
  These core hardware components form the baseline functionality needed to capture images, process them (locally or in the cloud), and provide audio output.

Software Components

- **Image Processing & Machine Learning**:
  - A pre-trained model can handle tasks like image segmentation, object labeling, and text extraction (for product labels and prices).
  - Alternatively, a custom pipeline may rely on classical computer vision feature extraction (e.g., SIFT, ORB), trained via small datasets.
- **Networking & Cloud Services**:
  - If the Raspberry Pi lacks sufficient processing power for robust models, images can be offloaded to a cloud-based server.
  - The server returns relevant information (e.g., product name, price) to the device, which then vocalizes it to the user.
- **Text-to-Speech Module**:
  - Converts recognized text or labels into spoken output.

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4. Use Cases

4. **Grocery Shopping** *(Target Goal for Functioning Prototype)*
   - A visually impaired person walks into a grocery store
   - Customer is greeted
   - The user wears the glasses while shopping.
   - User finds a product in store.
   - By pointing the camera at a product and pressing the capture button, the image is sent to a local or cloud-based AI.
   - The device identifies the product name, price, and other key details, relaying them back to the user via the speaker.
5. **Public Transit Identification** *(Reach Goal for Functioning Prototype)*
   - The glasses identify bus signage or route numbers to help a user select the correct bus.
   - Can integrate with navigation apps for real-time transit location updates or route planning.
6. **Indoor Navigation** *(Reach Goal for Functioning Prototype)*
   - In large environments like universities or offices, the device can detect signage or landmarks.
   - An optional mapping system (e.g., an AR-like approach with audio cues) could guide the user to specific rooms.

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5. Implementation Plan

7. **Hardware Setup**

- Acquire the Raspberry Pi (or similar microcontroller), camera module, speaker, and necessary peripherals.
- Assemble these components onto a 3D-printed glasses frame.

8. **Software & AI Integration**
    - Configure an operating system on the Raspberry Pi to handle basic I/O and networking.
    - Integrate a pre-trained AI model or a custom machine learning pipeline.
    - Test image capture, data transmission, and text-to-speech features in controlled settings.
9. **Cloud Infrastructure**
    - Set up a remote server with the trained model, if local computation is insufficient.
    - Implement a REST API or equivalent for seamless communication between the glasses and the server.
10. **Testing & Iteration**

- Pilot test the prototype with a small set of sample products under various lighting conditions.
- Gather user feedback and refine the hardware form factor, user interface, and software reliability.

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6. Estimated Budget

Item	Approx. Cost (USD)
Raspberry Pi (Model 4)	\$35–\$55
Official Pi Camera Module	\$10–\$30
Speaker/Audio Module	\$5–\$20
3D-Printed Glasses Frame	\$10–\$30
Battery/Power Supply	\$20–\$40
Misc. Cables/Mounts	\$10–\$20
Total	**\$90–\$195**

These estimates focus on prototype-level builds, assuming small production volumes and standard retail pricing. Costs can be reduced through bulk purchasing or sourcing alternative components.

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7. Differentiation & Future Directions

Existing AI-powered wearable solutions include Envision Glasses, OrCam, MyEye, eSight, and others; however, many of these devices have higher price points or proprietary platforms. Our project aims to stand out by prioritizing:

- **Affordability** through low-cost hardware.
- **Customization** via open-source software, enabling easy feature additions and adjustments.
- **Integration** with external services (e.g., cloud or local servers for AI processing).

Potential future enhancements:

- **Advanced Object Recognition** for more complex product details or environment mapping.
- **Facial Recognition & Social Interaction** (with proper privacy considerations).
- **Additional Navigation Features**, such as AR audio cues for movement in unfamiliar spaces.

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8. Project Timeline for Hardware/Software Assembly

Below is a rough **high-level timeline** of our product, from our proposal to the deadline. Each phase is approximately one to two weeks, but actual durations may vary based on team size and resources.

Phase	Duration	Key Activities
Phase 1: Hardware Acquisition & Setup	Weeks 1–2	- Order/purchase Raspberry Pi, camera module, speaker, etc. - Prepare 3D-printed frame or alternative design. - Install OS on Raspberry Pi and set up development environment.
Phase 2: Base Software Integration	Weeks 2–3	- Test image capture. - Configure text-to-speech. - Basic software test on hardware (power, button press).
Phase 3: AI & Cloud Link	Weeks 3–4	- Implement networking to connect Pi to cloud service. - Set up AI model on cloud server / local environment. - Run initial image recognition tests and refine model.
Phase 4: User Interface & Feature Build	Weeks 4–5	- Develop user prompts and speaker outputs. - Optimize data flow (camera → AI → text-to-speech). - Conduct iterative tests with different lighting/product types.
Phase 5: Pilot Testing & Iterations	Weeks 5–6	- Gather feedback. - Adjust hardware form factor (3D-printed frame adjustments).
Phase 6: Final Assembly & Debugging	Weeks 6–7	- Perform more testing. - Identify and fix remaining bugs in hardware/software integration. - Document final design and prepare for competition deadlines.

Key Competition Dates:

- Proposal Due: **February 17, 2025 (10 PM)**
- Finalists Notified: **February 21, 2025**
- Presentation of Project: **On or about May 2, 2025**

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9. Conclusion

This AI-integrated vision glasses prototype offers a cost-effective platform to assist visually impaired individuals in daily tasks, particularly identifying store products, but also navigating public transit. The project demonstrates a clear path to an impactful assistive device with clear benefits to those with assistive needs, who are typically not given the tools they need to be independent in locations such as those listed.

Within the **MUCAT Design Innovation Competition**, this concept satisfies the requirement for a user-centered, interdisciplinary initiative aligned with assistive technology goals. We hope that our design proposal has illustrated that our team can effectively plan and design this assistive technology device while adhering to the competition's guidelines and timelines.

End of Proposal.