Project Proposal: Smart Glasses for Prosopagnosia

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Problem Description and Statement (Part 1 - Due June 30)

Prosopagnosia, or face blindness, affects approximately 1-2% of the population, impairing their ability to recognize even familiar faces, which can lead to severe social and emotional challenges. Existing interventions, such as cognitive therapy and mobile applications, are often ineffective in real-time social interactions due to their invasive or cumbersome nature. This project proposes the development of smart glasses equipped with facial recognition technology to provide real-time, discreet identification of known individuals. This technology aims to seamlessly integrate into the daily lives of those affected, enhancing their social interactions and emotional well-being.

Thesis: The project addresses the significant challenge of prosopagnosia by creating wearable smart glasses that use real-time facial recognition to help individuals identify familiar faces, thereby improving their quality of life and social engagement.

Related Works (Part 1 - Due June 30)

- **Duchaine, B., & Nakayama, K. (2006). "Developmental prosopagnosia: a window to content-specific face processing."** This research paper explores the cognitive and neural mechanisms underlying face recognition impairments, particularly in individuals with prosopagnosia. The study offers valuable insights into the challenges faced by these individuals, making it foundational for understanding the user needs our project addresses. This knowledge will help tailor the facial recognition algorithms to be more effective for users with face blindness. Link

- **Rosebrock, A. (2017). "Real-Time Facial Recognition with OpenCV and Python."** This tutorial provides a step-by-step guide on implementing facial recognition using OpenCV, a popular computer vision library, and Python. It covers essential techniques for facial detection and real-time processing, which are critical for the development of our smart glasses. The methods outlined will be directly applied to the software development phase of our project. Link

- **Hein, A., & Steve, W. (2015). "Designing wearables for use in real-world applications: Factors of acceptability and usability."** This article explores the design considerations necessary to ensure that wearable technologies are both functional and user-friendly. It emphasizes the importance of creating devices that are unobtrusive and aesthetically pleasing, which aligns closely with our goal of developing discreet smart glasses for individuals with prosopagnosia. The insights from this paper will guide the ergonomic design of our product, ensuring it integrates seamlessly into everyday social scenarios. Link

Technical Requirements (Part 1 - Due June 30)

Baseline Requirements

- **Camera Specifications:** Equipped with cameras capable of capturing detailed facial features. The glasses have right and left cameras providing image feeds to the onboard hardware. The dual cameras provide image/hardware redundancy.
- **Facial Recognition Software:** Utilizes a hard-coded, predetermined database of known faces for recognition, avoiding the need for real-time updates and ensuring privacy. This is reflected in the object detection and cropped image processes leading to recognition.
- **System Connection:** Wired connection to external hardware for reliable, high-speed processing, as shown by the connection between onboard hardware and external hardware.
- **Auditory Alerts:** The user is provided with an auditory alert that details the individual that has been recognized, as well as the means to recognize them and info about how they relate to the user.

Nice-to-Haves

- **Wireless Image Transmission:** Ability to transmit images wirelessly, enhancing user mobility and convenience.
- **Battery Life:** Development of a battery capable of supporting at least a few hours of usage, making the glasses more practical for daily wear.
- **Database Management:** Functionality to update and add new faces to the database, allowing the system to adapt to new social interactions over time.
- **3D Analysis:** Use both cameras for stereoscopic vision and 3D analysis, possibly improving performance.
- **Visual Alerts:** Add a method of highlighting the area of the lens where the recognized individual has been detected.

Architecture (Part 1 - Due June 30)

The architecture consists of the following components:

- **Glasses:** Equipped with right and left cameras feeding images to the onboard hardware.
- **Onboard Hardware:** Performs object detection and crops images before sending them to external hardware for recognition.
- **External Hardware:** Contains modules for recognition, text generation, and database management (image and contextual databases).
- **Earpiece:** Provides audio feedback to the user about the recognized individual.

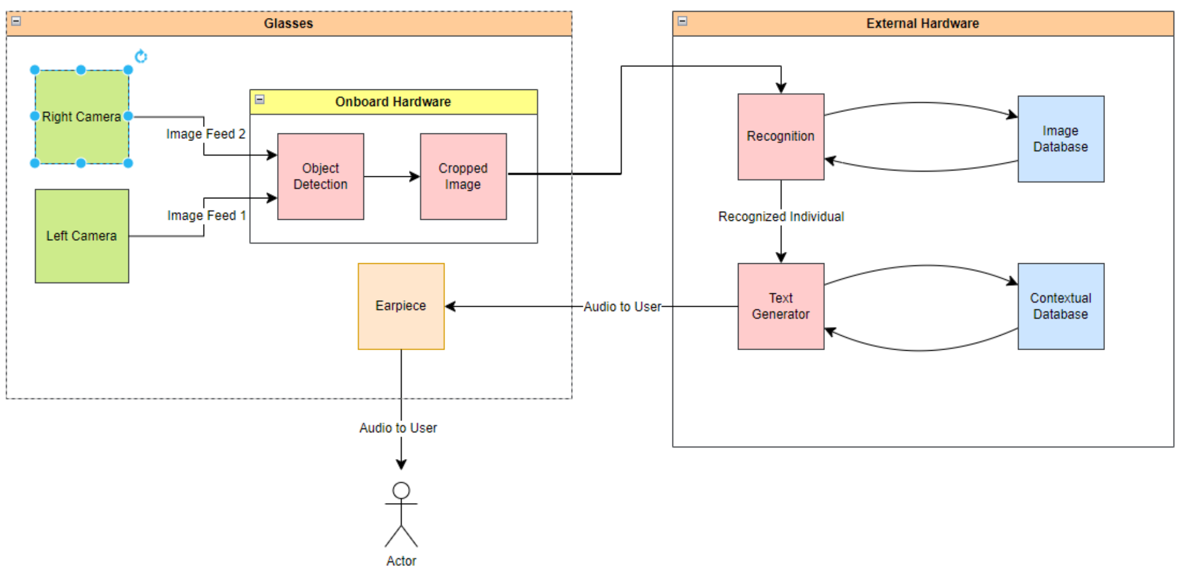

Figure 1: Architecture Diagram

Alternative Architecture: A viable alternative would have been a fully integrated system where the glasses operate independently with an embedded AI processor and internal memory. This design was not chosen due to the increased complexity and cost of embedding powerful processing capabilities directly into the glasses, which could also compromise the lightweight and comfort aspects critical for daily wear. This is, however, our final goal as described in the nice-to-haves section.

Implementation Details (Part 1 - Due June 30)

This section details the implementation of the requirements and architecture described above.

Data Description and Preparation

- **Data Attributes:** The project will utilize a facial recognition dataset comprising images labeled with individuals' identities. Important attributes include facial features captured under various lighting and angles.
- **Data Preparation:** Involves cleaning techniques such as noise reduction and normalization. Feature engineering will focus on enhancing facial feature recognition, such as edge detection and symmetry analysis.
- **EDA Visuals:** Include distribution of face orientations and lighting conditions to understand dataset diversity and balance.

Models and Algorithms

- **Need for AI:** AI is crucial for recognizing complex patterns in facial features that vary greatly across different individuals and conditions.
- **Recommended Model:** A Convolutional Neural Network (CNN) is recommended due to its proficiency in image data analysis, particularly for tasks involving recognition and classification.
- **Model Details:** We will use a pre-trained model like MobileNet due to its efficiency in mobile environments, utilizing depth-wise separable convolutions to reduce computation power without compromising accuracy. One of the main "nice-to-haves" is an in-house mobile model designed by our team.
- **Inputs and Outputs:** Inputs will be image frames from the glasses' cameras; outputs will be the recognized individual's name and contextual information about the recognized individual.
- **Training and Fine-tuning:** The model will be fine-tuned on a specific dataset of known individuals using transfer learning, adjusting the final layers to specialize in the target recognition tasks.
- **Alternative Models:** Alternatives like Support Vector Machines (SVM) and traditional face recognition algorithms were considered. SVM was not chosen due to its inefficiency with large-scale image data, and traditional algorithms lacked the robustness required for variable conditions.

Onboarding Plan and Resources (Part 2 - Due July 21)

[Describe the detailed plan for onboarding your team, including technical workshops, tasks, and resources to help them learn foundational topics. Incorporate their ideas after initial discussions and provide continuous support through resources and guidance.]