Project Proposal Report

for

AI-Driven Smart Assistive Ecosystem: An Embedded System Integration of Computer Vision Glasses and Sensor-Based Gloves for Inclusive Accessibility

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Team Information

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Abstract

The **Smart Assistive Ecosystem Project** aims to create an inclusive and intelligent communication and navigation system that empowers individuals with visual, hearing, and speech impairments. The ecosystem integrates three core components (**Smart Glasses**, **Smart Gloves**, and a **Mobile Application**) to facilitate seamless interaction and independence. The Smart Glasses assist blind users by reading text aloud, recognizing objects and faces, and providing navigation guidance. The Smart Gloves enable deaf and mute users to communicate by translating sign language gestures into speech or text and converting spoken input into tactile or visual feedback. Acting as the central hub, the Mobile Application connects both devices, managing translation, communication, and personalization features. Through AI integration, emotion detection, and cloud connectivity, the system not only bridges communication gaps between different disabilities but also enhances accessibility, independence, and social inclusion.

Problem Statement and Motivation

Millions of individuals worldwide face daily challenges due to visual, hearing, or speech impairments. These limitations hinder their ability to communicate effectively, navigate safely, and live independently. Current assistive tools often focus on one disability at a time and fail to integrate communication between different impairment groups. Our motivation is to create an all-in-one system that bridges this gap, enabling real-time communication and navigation through intelligent, affordable, and accessible technology. The project primarily impacts people with disabilities, their families, and institutions supporting inclusive communities.

Problem Solution

The **Smart Assistive Ecosystem (SymbioTech)** offers an integrated, AI-driven solution that directly addresses the communication and navigation challenges faced by individuals with visual, hearing, and speech impairments. Current assistive tools often focus on a single disability and fail to enable cross-interaction among different impairment groups. SymbioTech overcomes this limitation by combining **Smart Glasses**, **Smart Gloves**, and a **Mobile Application** into one unified, intelligent ecosystem.

1. **Smart Glasses**
   Designed for visually impaired users, the glasses utilize a built-in camera, sensors, and AI algorithms to recognize text, objects, faces, and surroundings. They can read printed text aloud and provide real-time audio feedback to assist in navigation and object identification. Optional GPS integration enhances mobility and safety, while cloud-based AI and emotion detection improve user interaction, transforming the glasses into a personal assistant rather than a simple aid.

2. **Smart Gloves**
   The gloves assist deaf and mute individuals by translating hand gestures into speech or text using flex sensors, accelerometers, and a microcontroller. They transmit gesture data via Bluetooth or Wi-Fi to the mobile app for instant translation. The gloves also receive spoken input, converting it into vibrations or text for two-way communication, thus enabling meaningful interactions with both hearing and visually impaired individuals.

3. **Mobile Application**
   The app acts as the control center linking both devices. It processes data, manages translation between gesture, text, and speech, and provides customizable communication modes. It also includes real-time chat, navigation support, voice-to-text and text-to-speech conversion, and personalized settings. Through AI integration and cloud connectivity, the app ensures smooth synchronization, accessibility, and scalability.
   This system directly tackles the isolation caused by sensory disabilities by creating a bridge for real-time communication between individuals with different impairments. It empowers users to interact independently, navigate safely, and participate actively in daily life. Unlike single-purpose assistive devices, SymbioTech promotes **inclusivity, communication, and collaboration** across disabilities.

Key Features:

- AI-based text, object, and face recognition
- Gesture-to-speech and speech-to-text translation
- Two-way communication with real-time feedback
- Customizable interface and user preferences
- Cross-platform accessibility via mobile application

Project Scope

-In Scope :

The Smart Assistive Ecosystem will focus on designing, developing, and integrating three core components to create an inclusive assistive system:

- **Smart Glasses**: Prototype capable of text reading, object recognition, and basic obstacle detection using AI and ultrasonic sensors.

- **Smart Gloves**: Functional prototype to detect hand gestures and convert them into speech or text in real time using flex sensors and a microcontroller.

- **Mobile Application**: Acts as the central communication hub, connecting both devices via Bluetooth or Wi-Fi for real-time data exchange, gesture translation, and voice/text conversion.

- **AI Integration**: Implement machine and deep learning for basic text and object recognition, and enable voice/text translation features.

- **User Interface**: Simple and accessible mobile app interface allowing customization and real-time interaction.

- **Testing and Evaluation**: Conduct testing on communication accuracy, response time, and user experience to assess performance and usability.

-Out of Scope:

To maintain focus and manage development efforts, the following aspects are **not included** in the current project phase:

- **Full-scale commercial production** or mass manufacturing of the devices.

- **Integration with third-party assistive systems** or medical databases.

- **High-precision GPS navigation** for outdoor use (basic navigation guidance only).

- **Cloud-based data storage and large-scale server deployment.**

- **Long-term clinical trials or certification** for medical-grade use.

High-Level Timeline

- **Research & Requirements**: Literature review, market analysis, technology selection – 2 weeks
- **Design**: System architecture, UI/UX, and hardware schematics – 2 weeks
- **Implementation 1**: Hardware – 4 weeks
- **Implementation 2**: Software – 4 weeks
- **Testing**: Unit testing, usability testing – 2 weeks
- **Integration**: Hardware-software sync - 2 weeks
- **Final Report & Presentation**: Documentation and demo preparation – 2 week

Technology Stack

Microcontroller: ESP32-CAM (for vision and connectivity)
Sensors: Ultrasonic sensor, accelerometer, flex sensors, LiDAR
Programming Languages: Python, C++, JavaScript
Frameworks: TensorFlow Lite, Flask (for backend), Android Studio (for app)
Database: Firebase (for cloud storage)

These technologies are open-source, low-cost, optimized for IoT and AI integration, suitable for real-time assistive applications and they are lightweight. They also work together where the ESP32-CAM connects with the Ultrasonic and LiDAR with its WiFi module installed.

Success Metrics

- **Functional Accuracy**: Expected to have ≥90% accuracy in object detection for Glasses and gesture recognition for Gloves.
- **User Testing**: Positive feedback from at least 80% of trial users that will be measured using surveys and forms from users.
- **System Reliability**: Stable wireless connectivity between glasses, gloves and phone and smooth device-app interaction measured with testing the devices.

Roles & Contributions

All team members collaboratively contributed to every aspect of the project, including feature development, model design, user interface creation, literature survey, idea formulation, framework setup, and documentation. The team ensured that each member had a clear understanding of every component before individual responsibilities were assigned. This collective approach fostered equal participation, knowledge sharing, and consistent project quality across all stages.