CSAI 498 / CSAI 499 – Graduation Project Proposal Template

- Submission: Week 6 Deliverable Type: Written Report (PDF + GitHub link)

Cover Page

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

• Team Members: (include student name, ID, and program – SWD / IT / DSAI)

	Student Name	ID	Program
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• Supervisor: Mohamed Maher

• Semester / Year: 7th semester/ 4th year

• Date of Submission: 25/10/2025

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 & Motivation → (SO 1)

Millions of people worldwide struggle with visual impairments that limit their ability to navigate safely, recognize objects or people, and access written information. Existing assistive tools often address only one aspect of the problem, such as text reading or obstacle detection, without providing unified or intelligent experience. This lack of integration reduces independence and confidence for visually impaired individuals in daily life.

The **Smart Assistive Ecosystem Project** aims to solve this challenge by developing a unified ecosystem that connects multiple assistive devices including Smart Glasses for the visually impaired and Smart Gloves for the deaf and mute through a central mobile application.

In this phase, we began with Smart **Glasses**, which represent the first device in our ecosystem. The purpose of developing the Smart Glasses first is to establish a reliable foundation for object detection, text reading, and environmental awareness using AI and sensor technology. These glasses will eventually integrate with other components to enable complete communication and navigation support within the ecosystem.

Proposed Solution → (SO 1 & SO 2)

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.

Project Scope → (SO 2)

-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 → (SO 2)

Phase	Description	Duration (weeks)	Deliverables
Research & Requirement Analysis	Conduct a comprehensive literature review, analyze existing assistive technologies, and select appropriate tools and hardware.	2-weeks	Complete research report on related projects and a detailed requirements specification document.
Design & Planning	Develop the overall system architecture, design UI/UX interfaces, and prepare detailed hardware schematics for the devices.	2-weeks	System design for smart glasses, smart gloves, and mobile application, including software planning documentation.
Implementation Part 1	Build and assemble the hardware components for the smart glasses and gloves.	4-weeks	Fully functional hardware prototypes of the smart glasses and smart gloves.
Implementation Part 2	Develop and integrate the software system, including AI model deployment and mobile application connectivity.	4-weeks	Fully integrated hardware-software system with operational software modules.

Testing & Evaluation	Perform unit testing, functionality testing, and usability evaluation of the complete system.	2-weeks	Testing and evaluation report summarizing results, issues, and improvements.
Integration	Synchronize and optimize communication between hardware components and software systems.	2-weeks	Seamlessly integrated and synchronized system of smart glasses, smart gloves, and mobile application.
Final Report & Presentation	Prepare the final documentation and demonstrate the project functionality.	2-weeks	Complete project report, user documentation, and final demo presentation.

Technology Stack & Theoretical Basis → (SO 6 – Program Specific)

•**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 & Evaluation Plan → (SO 2 & SO 6)

- **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.

Team Roles & Responsibilities → (SO 5 & SO 3)

Team Member	Program	Primary Role	Technical Contribution (SO 6 Focus)
Rudaina Haitahm	DSAI	AI Engineer	Responsible for developing and training the AI models used in the assistive devices.
Hana Amr	DSAI	AI & Hardware Engineer	Leads the hardware integration of the smart gloves and smart glasses, including model deployment on embedded systems.
Youssef Ahmed	SWD	Software Engineer	Develops and maintains the software application interface for device communication and user interaction.

References

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Submission Checklist

1. Report (PDF) uploaded to Classroom.
2. Team roles and program-specific contributions clearly identified for each team member.
3. All sections completed and formatted according to template.