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TED UNIVERSITY

CMPE 491-0 SENIOR PROJECT

ANALYSIS REPORT

Team Members:

Ceyda Kuşçuoğlu(16348076072)

Kıvanç Terzioğlu(27233564574)

Berkay Kaan Karaca(68317070956)

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1. Introduction

The Voice Assistant for Visually Impaired (VAVI) is an intelligent navigation system designed to enhance the mobility and independence of visually impaired individuals in indoor environments. It provides real-time audio guidance and obstacle detection to help users navigate safely and confidently. The system aims to offer a cost-effective and user-friendly solution for visually impaired individuals in locations such as schools, offices, shopping malls, and hospitals.

2. Current System

Currently, visually impaired individuals rely on traditional mobility aids such as white canes, guide dogs, or human assistance to navigate indoor environments. While these methods are effective to some extent, they have limitations, including the inability to provide real-time navigation assistance, detect obstacles dynamically, or guide users to specific destinations within complex indoor spaces. Existing navigation systems for visually impaired individuals often rely on expensive or impractical hardware, limiting accessibility and affordability.

3. Proposed System

3.1 Overview

The VAVI system is designed to address the limitations of traditional mobility aids by integrating real-time image processing, voice-based interaction, and intelligent navigation. The system captures the surrounding environment using a camera, processes the data to detect objects and obstacles, and provides step-by-step voice instructions to help users navigate safely.

3.2 Functional Requirements

1. Real-Time Object Detection: The system must detect and classify objects (e.g., walls, doors, furniture) using advanced image processing algorithms.
2. Obstacle Avoidance: The system must identify moving and stationary obstacles and provide immediate audio alerts.
3. Voice-Based Navigation: Users must be able to issue voice commands to request navigation assistance (e.g., "Take me to the cafeteria").
4. Mapping and Localization: The system must utilize pre-mapped indoor environments (e.g., a school layout) and accurately determine the user's position within that environment to provide guidance.

5. User Interface: The system must offer an intuitive voice-controlled interface that does not require visual interaction.
6. Accessibility: The system must be designed specifically for visually impaired individuals, ensuring ease of use and clarity in navigation instructions.

3.3 Nonfunctional Requirements

1. Performance: The system must process images and provide feedback in real-time, with a response time of less than 1 second.
2. Accuracy: Object detection and navigation instructions must have an accuracy rate of at least 90%.
3. Portability: The system must be lightweight and deployable on smartphones or wearable devices.
4. Battery Life: The system must operate for at least 8 hours on a single charge.
5. Scalability: The system should be adaptable to various indoor environments and capable of handling dynamic changes in layout.

3.4 Pseudo Requirements

1. The system should prioritize open-source software and affordable hardware components.
2. The user interface should be entirely voice-based to eliminate the need for screen-based interactions.
3. The system should ensure data privacy by processing user information locally without transmitting sensitive data to external servers.

3.5 System Models

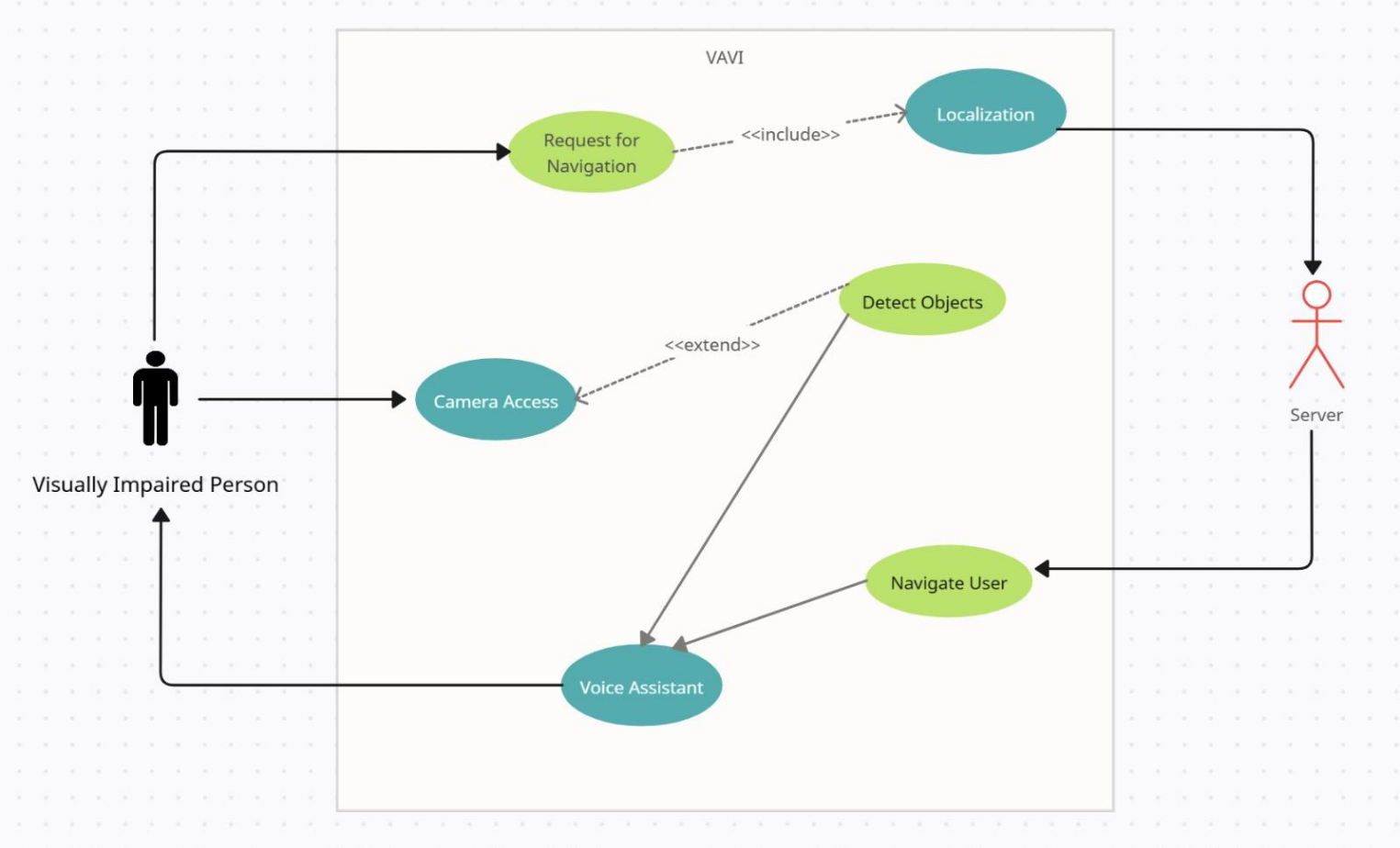
3.5.1 Scenarios

- Scenario 1: Navigation Assistance
    - A user enters a shopping mall and asks the system, "Take me to the pharmacy."
    - The system calculates the optimal path and provides step-by-step voice instructions.

- Scenario 2: Obstacle Detection
    - While walking, the user approaches an obstacle (e.g., a chair in the pathway).
    - The system detects the obstacle and warns the user, "Obstacle ahead, move left."

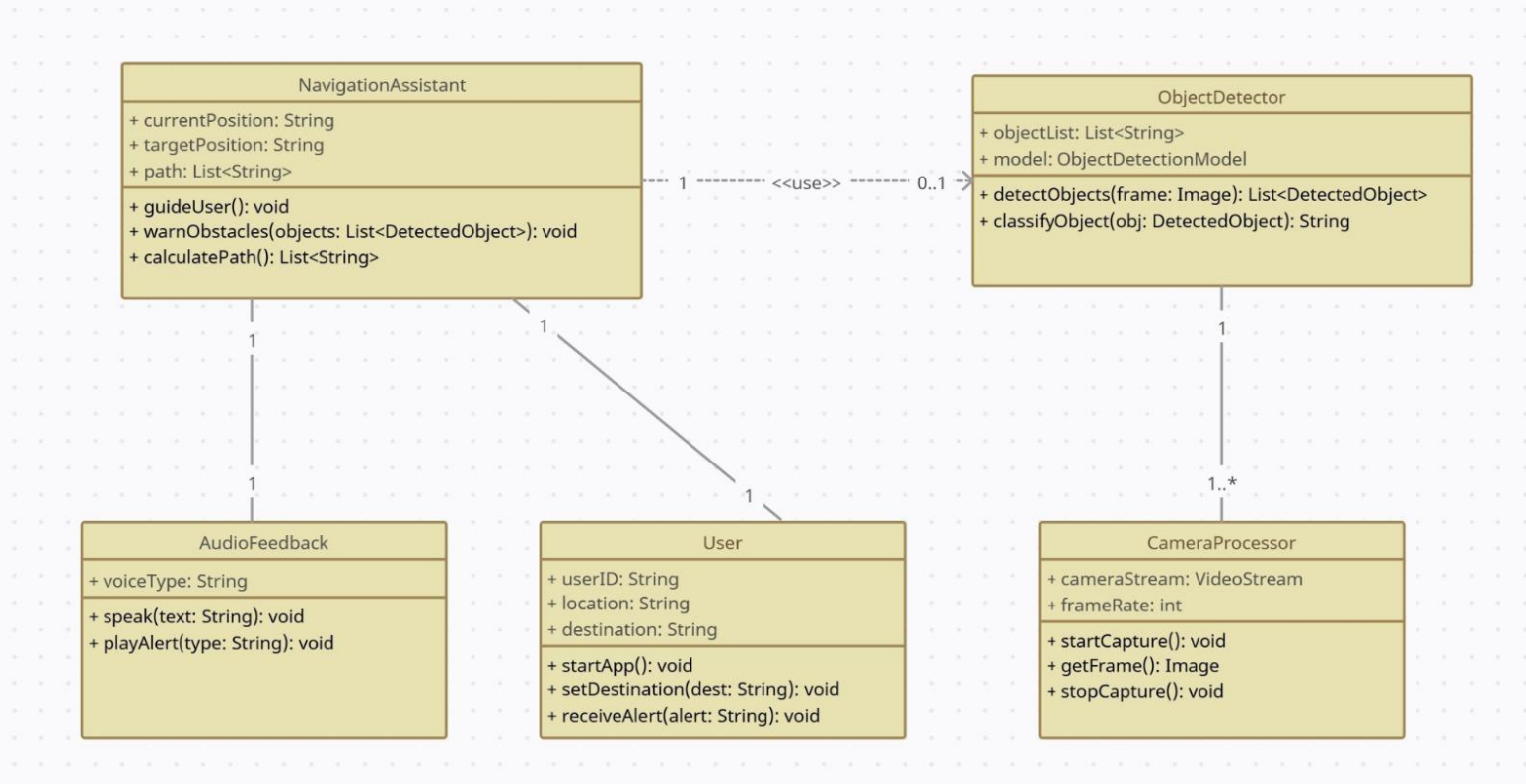
3.5.2 Use Case Model

- Actors: Visually impaired user
- Use Cases:
    1. Request navigation assistance
    2. Detect obstacles and receive alerts
    3. Update or calibrate the environment map
    4. Adjust voice settings for better clarity



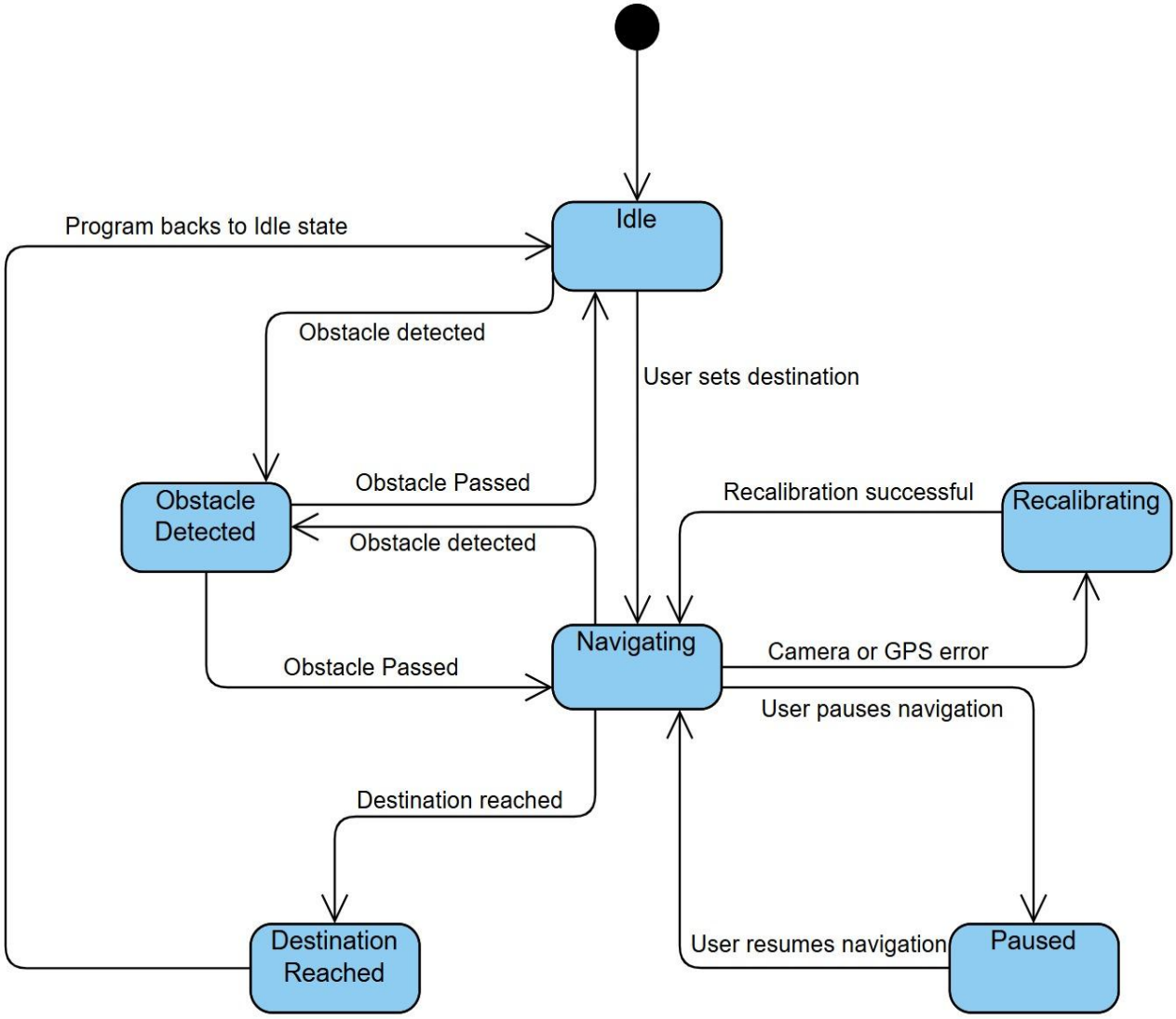
3.5.3 Object and Class Model

- Objects: User, Environment, Camera, Voice Assistant
- Classes: Object Detection, Navigation System, Voice Processing, User Interaction



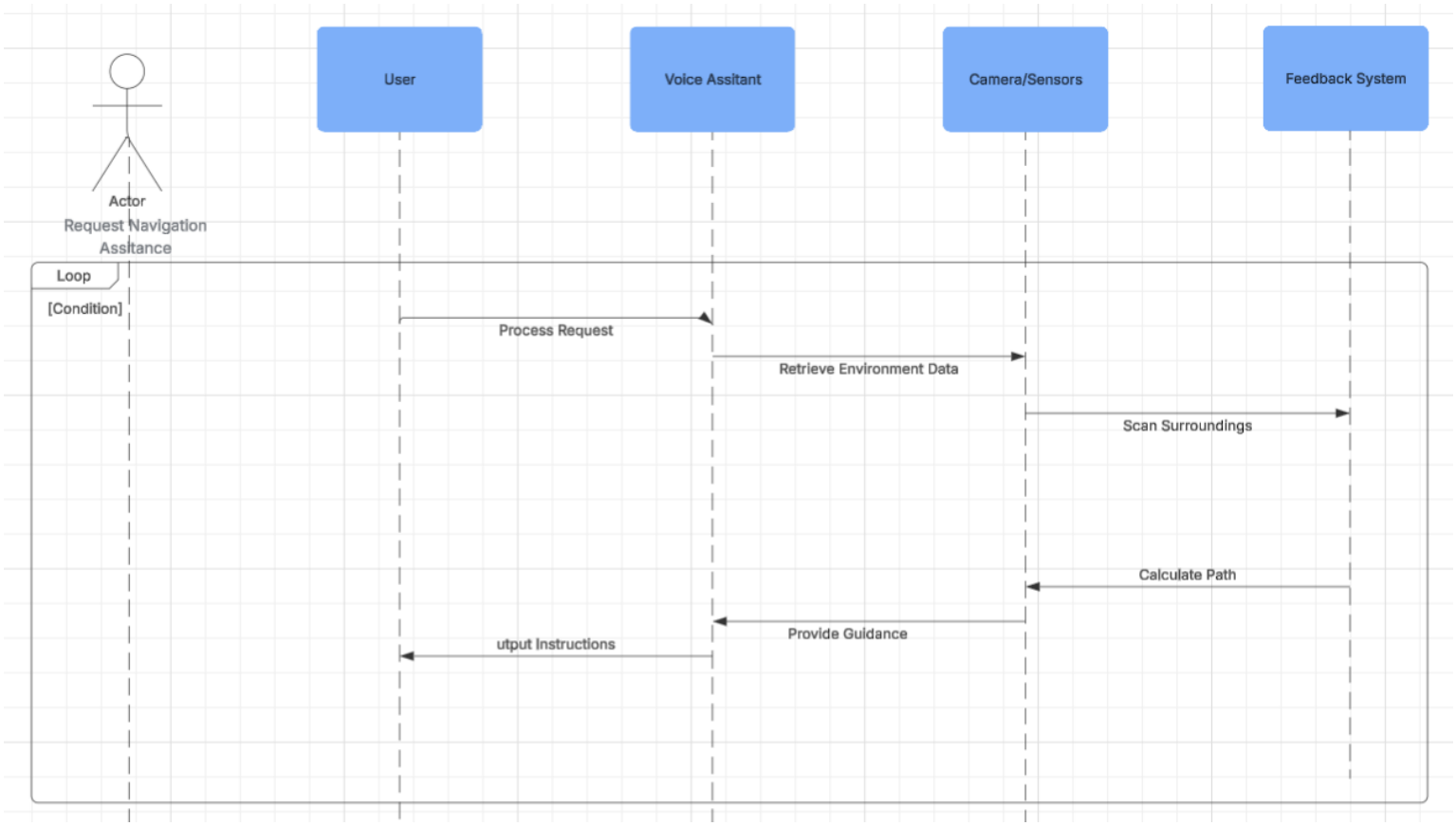
3.5.4 Dynamic Models

- State Diagram: Represents user interaction states, such as idle, navigating, recalibrating, and obstacle detection.



(State Diagram)

- Sequence Diagram: Illustrates the flow of actions when a user requests navigation assistance.



(Sequence Diagram)

3.5.5 User Interface - Navigational Paths and Screen Mock-Ups

Since the system is fully voice-controlled, a voice-based menu will be the primary interface:

- Main Menu: "Where would you like to go?"
- Navigation Mode: "Turn right in 5 meters."
- Obstacle Alert: "Caution! Stairs ahead."

4. Glossary

- SLAM (Simultaneous Localization and Mapping): A technology used to map an environment while tracking the user's location.
- Object Detection: The process of identifying objects in the environment using computer vision.
- Voice-Based Interaction: A system that allows users to communicate through voice commands instead of a visual interface.

5. References

1. ACM Code of Ethics and Professional Conduct: https://www.acm.org/code-of-ethics
2. IEEE Code of Ethics: https://www.ieee.org/about/corporate/governance/p7-8.html
3. Software Engineering Code of Ethics: https://www.computer.org/education/code-of-ethics
4. Object-Oriented Software Engineering, Using UML, Patterns, and Java, 2nd Edition, by Bernd Bruegge and Allen H. Dutoit, Prentice-Hall, 2004, ISBN: 0-13-047110-0