Software Requirements Specifications

ENVIRONMENT DETECTION FOR BLIND USERS

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EDBP-2025

Internal Advisor:

Prof. Muhammad Fahad

Project Manager:

Dr. Muhammad Ilyas

Project Team:

Ali Raza Ansari (BSCS51F22S008) — Team Leader
Abdullah Zammad (BSCS51F22S036) — Team Member
M. Hassan (BSCS51F22S040) — Team Member

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Author(s)	Ali Raza Ansari (BSCS51F22S008) Abdullah zammad (BSCS51F22S036) M. Hassan (BSCS51F22S040)
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Definition of Terms, Acronyms and Abbreviations.

Term	Description
TFLite	TensorFlow Lite
RTOD	Real Time Object Detection
TTS	Text-To-Speech
YOLO	You Only Look Once
Flutter	Cross-platform mobile framework
OpenCV	Open Source Computer Vision Library
EDBP	Environment Detection for Blind People

Table of Content

1. Introduction

1.1 Purpose of Document

This document outlines the objectives, scope, and features of the “Environment Detection System for Visually Impaired Users” project, which uses AI-based object detection and audio feedback to help visually impaired individuals identify objects in their environment. It is intended for supervisors, evaluators, developers, and stakeholders involved in the project’s design and development.

1.2 Project Overview

"Environment Detection System for Visually Impaired Users" is an AI-powered mobile application that detects objects through a smartphone camera and provides real-time audio feedback , helping visually impaired users navigate safely and confidently. It aims to enhance independence, mobility, and awareness in everyday life.

1.3 Scope

Included:

- Real-time object detection using smartphone camera
- Image preprocessing
- Audio feedback generation using offline Text-to-Speech (TTS)
- Direction identification (Left and Right)
- Continuous real-time operation
- Simple and accessible mobile interface

Not Included:

- Distance estimation between user and objects
- Object size measurement
- Navigation or path planning features
- IoT or external hardware integration
- Facial recognition or text reading (OCR)

2. Overall System Description

The Environment Detection System for Visually Impaired Users is an AI-based system designed to help visually impaired individuals recognize objects in their surroundings through real-time audio feedback. The system uses a camera to capture visuals, processes them and provides speech output to guide the user safely and independently.

2.1 User characteristics

- **Primary users:** are visually impaired individuals who rely on audio feedback for object recognition and navigation.
- **Secondary users:** include developers, testers, and system administrators responsible for installation, updates, and maintenance.
- **The most critical users:** are visually impaired individuals, as system usability and safety directly impact them.

2.2 Operating environment

- **Frontend:** Flutter (Mobile Application)
- **AI Framework:** TensorFlow Lite (TFLite)
- **Computer Vision:** OpenCV library
- **Object Detection Model:** YOLOv8
- **Audio Output:** Text-to-Speech (TTS)
- **Platform:** Mobile-based (Android)

2.3 System constraints

- **SC-1 Software Constraints:**
  Real-time object detection may be slowed by the system's data-handling speed and overall performance.
- **SC-2 Hardware Constraints:**
  The system needs a working camera, earphones, and enough memory to run its features.
- **SC-3 Cultural Constraints:**
  The system currently supports only English, but additional languages can be added later.
- **SC-4 Legal Constraints:** The system must keep user data private and meet accessibility standards.

- **SC-5 Environmental Constraints:** Detection accuracy may decrease in low-light conditions or when the camera moves excessively. The system will provide audio warnings when environmental conditions are not optimal.
- **SC-6 User limits:** The primary interaction relies on audio feedback; minimal visual elements are included for setup and debugging.
- **SC-7 Model size constraints:** The trained model must be lightweight enough (<50MB) to run efficiently on mobile devices.
- **SC-8: Object Limitation:**
  The initial release shall detect a limited set of objects (e.g., chairs, tables) with the capability to expand through model updates.

3. External Interface Requirements

The Smart Assistant for Visually Impaired users (EDBP-2025) connects to hardware such as cameras and earphones, uses software frameworks such as TensorFlow Lite and OpenCV, and provides audio output via TTS.

3.1 Hardware Interfaces

The system interfaces with cameras, and earphones.

- The camera captures images of the surroundings for object detection.
- The earphones enable audio interaction between the user and the system.

3.2 Software Interfaces

The system combines several software components:

- **Frontend:** Built with Flutter, it delivers an easy-to-use, interactive mobile app for users.
- **AI framework:** Uses TensorFlow Lite (TFLite) for device-level object detection.
- **Computer vision:** Uses the OpenCV library to get images ready for analysis.
- **Object detection:** YOLOv8 trained on custom dataset
- **Operating system:** Works with the Android platform.

3.3 Communications Interfaces

The system uses the smartphone camera to capture images in real-time. Processing occurs on-device using TFLite without requiring internet connectivity for core functionality. Audio feedback is provided through the device speaker or earphones using Text-to-Speech (TTS) engine.

4. Functional Requirements

- **FR-1 Object Detection:**
  The system shall capture images using the camera and identify surrounding objects using YOLOv8 model with TensorFlow Lite.
- **FR-2 Image Preprocessing:**
  The system shall prepare captured images by resizing, adjusting, and enhancing clarity using OpenCV.
- **FR-3 Direction Identification:**
  The system shall determine whether objects are to the left, center or right of the user.
- **FR-4 Audio Feedback:**
  The system shall turn detected objects and their directions into spoken words using the Text-to-Speech (TTS) tool.
- **FR-5 Real-Time Processing:**
  The system shall handle data and provide feedback in real time to support navigation.
- **FR-6 Confidence levels:**
  The system shall announce detected objects only when detection confidence exceeds a predefined threshold to reduce false positives.
- **FR-7 User Interface:**
  The mobile app, built with Flutter, shall be simple to use and require minimal input, making it suitable for visually impaired users.
- **FR-8 Language Support:**
  The system shall give audio feedback in English, with the option to add more languages later.
- **FR-9 Offline Operation:**
  The system shall function without an internet connection for its core detection and feedback features.

5. Non-functional Requirements

- **NFR-1 Performance:**
  The system shall provide object detection and audio feedback with minimal latency, typically under one second depending on device capability.
- **NFR-2 Accuracy:**
  The system shall maintain acceptable detection accuracy under normal environmental and lighting conditions.
- **NFR-3 Reliability:**

The system shall operate continuously without crashing during extended usage.

- **NFR-4 Safety:**
  The system shall prioritize user safety by avoiding misleading or delayed audio feedback.
- **NFR-5 Fault Notification:**
  The system shall notify the user through audio alerts in case of low lighting, camera obstruction, or system malfunction.
- **NFR-6 Privacy:**
  The system shall not store, transmit, or share captured images or personal user data.
- **NFR-7 Resource Usage:**
  The system shall operate efficiently with respect to battery consumption, memory usage, and processing resources.

6. Assumptions and Dependencies

6.1 Assumptions

- **AS-1:**
  Users will have access to compatible Android devices equipped with a camera and audio output.
- **AS-2:**
  The AI models and libraries (e.g., TensorFlow Lite, OpenCV) will remain available, stable, and compatible with future software updates.
- **AS-3:**
  The hardware components (camera, earphones) will function correctly and meet minimum performance standards.
- **AS-4:**
  Users will operate the system in normal environmental conditions with adequate lighting for object detection.
- **AS-5:**
  The Text-to-Speech (TTS) engine will be available on the device for offline operation.
- **AS-6:**
  The YOLOv8 TFLite model will be packaged within the application for offline use.
- **AS-8:** Users will hold the device in portrait orientation during use for consistent detection results.

6.2 Dependencies

- The project depends on third-party frameworks: TensorFlow Lite, OpenCV, and Flutter.
- The Text-to-Speech (TTS) engine and YOLOv8 model are external components whose updates or licensing changes may affect system performance.
- The system relies on the availability and quality of custom-trained YOLOv8 models for accurate object recognition.
- The Flutter framework version 3.0 or higher is required for development and deployment.
- The development timeline depends on the integration of TFLite with Flutter and mobile camera implementation.
- Performance depends on device processing capabilities for real-time inference.
- Model training requires sufficient dataset collection and annotation for target objects.
- The application is installed and tested directly on Android mobile phones.

7. References

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