VOICE AND GESTURE BASED APPLICATION FOR THE VISUALLY IMPAIRED

CS6611 – CREATIVE AND INNOVATIVE PROJECT

Submitted by

Vasundaraa Elango (2022103039)

Priyanka Akilan (2022103058)

Sulochana Haldorai (2022103580)

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BONAFIDE CERTIFICATE

Certificate that this project request titled **Voice and Gesture based application for the visually impaired** is the bonafide work of **Vasundaraa Elango (2022103039)**, **Priyanka Akilan (2022103058)**, **Sulochana Haldorai (2022103580)** who carried out the project work under my supervision, for the fulfilment of the requirements as part of the CS6611 – Creative and Innovative Project.

Dr. V. MARY ANITA RAJAM	**Dr. C. VALLIYAMMAI**	**Dr. G.S. MAHALAKSHMI**
Professor	**Professor**	**Assistant Professor**
HEAD OF THE DEPARTMENT	**SUPERVISOR**	**SUPERVISOR**
Department of Computer Science and Engineering, Anna University, Chennai – 600025.	Department of Computer Science and Engineering, Anna University, Chennai – 600025.	Department of Computer Science and Engineering, Anna University, Chennai – 600025.

ABSTRACT

This project introduces a mobile application designed to assist visually impaired individuals in independently interacting with their environment through the integration of computer vision and audio feedback. The application leverages real-time image processing and deep learning to detect and interpret objects, recognize printed text, identify currency denominations, and facilitate emergency communication, all via a simple and intuitive voice-controlled interface.

At its core, the application utilizes a YOLOv5 model for object detection, allowing users to receive immediate auditory descriptions of nearby items. This feature is particularly useful in daily activities such as identifying obstacles, locating household objects, or navigating unfamiliar spaces. In parallel, a robust text recognition system based on EasyOCR processes images of printed material, converting detected content into spoken words, thereby supporting users in reading books, signs, or documents independently.

Another key module is the currency detection system, which identifies Indian currency notes using handcrafted features - Hu moments, Haralick textures, and colour histograms - classified by a Random Forest algorithm. This enables users to distinguish between different denominations accurately, promoting financial autonomy and confidence when handling money.

To address emergency situations, the application incorporates an SOS mechanism. When activated via a voice command or gesture, the system retrieves the user's current geolocation and transmits a predefined emergency message along with the location coordinates to a registered contact. This ensures rapid communication in critical scenarios, enhancing personal safety.

The application is designed with simplicity and accessibility in mind, featuring gesture-based navigation that minimizes reliance on visual input. All core functionalities are triggered through intuitive swipes and voice prompts, ensuring ease of use for individuals with varying degrees of visual impairment. This project demonstrates the potential of assistive technology to create inclusive digital tools that promote autonomy, safety, and equal access for visually impaired users.

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Vasundaraa Elango **Priyanka Akilan** **Sulochana Haldorai**

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CHAPTER – 1
INTRODUCTION

In today's technology-driven world, accessibility and inclusivity are paramount. Yet, despite advances in mobile computing and artificial intelligence, a significant portion of the population - particularly those with visual impairments - continues to face challenges in performing routine tasks independently. Everyday activities such as reading printed text, recognizing objects, identifying currency, or seeking help during emergencies remain difficult without external assistance. While some solutions exist, they are often expensive, fragmented, or require internet connectivity and high-end devices, making them inaccessible to many.

This project emerges as a response to these gaps. It aims to develop a smart, unified, and affordable mobile application specifically tailored for the visually impaired. By combining computer vision and AI with a user-centric interface, the system is designed to assist users in real time, helping them navigate their environment safely and confidently. What sets this project apart is its focus on simplicity, offline usability, and voice-based interactions - ensuring that even users with minimal technical knowledge can operate it effectively.

The solution also strives for adaptability, offering support across multiple regions and languages, and maintaining relevance in both urban and rural settings. Moreover, the project emphasizes modularity and future expansion, laying the groundwork for broader innovations in the assistive technology space. The following sections detail the specific objectives, problem context, necessity, challenges, and potential scope of the system.

1.1 OBJECTIVE

The following are the key objectives of the project aimed at addressing the challenges faced by visually impaired individuals through a smart assistive application:

- Assist the visually impaired by providing real-time support through a mobile application using voice and gesture-based controls.
- Enable object detection, text reading (OCR), and currency recognition using computer vision and machine learning techniques.
- Provide an emergency SOS feature that instantly sends location-based alerts via SMS using Twilio API.
- Ensure complete voice interaction and intuitive gesture navigation to support users with zero visual input.
- Focus on accuracy, speed, and low resource usage, making the app usable even on mid-range smartphones.
- Design a simple, accessible interface suitable for both children and adults, requiring no technical expertise.
- Promote inclusive technology that prioritizes independence, dignity, and equal access for people with visual impairments.

1.2 PROBLEM STATEMENT

Despite the existence of many accessibility tools, most are fragmented, expensive, or demand high computational resources, making them inaccessible to those in underprivileged or remote regions. Visually impaired individuals often struggle with navigating everyday environments, identifying unfamiliar objects, and accessing textual information such as printed signs or documents. Moreover, during emergencies, they might find it difficult to quickly alert others without accessible tools. Many available apps lack offline support or are not intuitive for visually impaired users. Hence, there is a pressing need for an all-in-one, low-cost mobile solution that offers reliable real-time assistance in a manner that prioritizes usability, inclusivity, and performance. In many cases, current solutions are designed without user feedback from the visually impaired community, resulting in poor adoption. There is also a lack of culturally and linguistically diverse tools that can effectively support users in non-English-speaking regions.

1.3 NEED FOR THE SYSTEM

The need for an integrated assistive system stems from the growing global population of individuals living with vision-related disabilities. Existing solutions often require users to switch between multiple applications to perform different tasks, which can be confusing and inefficient. Moreover, most of these applications are developed without considering the cognitive and sensory constraints faced by the visually impaired. The proposed system addresses these gaps by bringing essential features under a unified interface, guided by voice prompts and simplified navigation. It also accommodates regional adaptability by supporting local languages and offline functionality, ensuring broader reach and applicability. Furthermore, the system can be used for educational purposes, helping visually impaired students engage more effectively with printed material. It also encourages digital inclusion by giving users a greater sense of control in a tech-driven society.

1.4 CHALLENGES IN THE SYSTEM

Building such a system comes with its own set of challenges. One of the primary hurdles is ensuring high accuracy in text and object detection across different lighting conditions and environments. Since users rely heavily on audio feedback, the timing and clarity of voice prompts are critical. Another challenge lies in balancing real-time performance with device resource constraints, especially in mid- or low-end smartphones. Furthermore, designing an interface that requires minimal user input, while still offering full control and functionality, demands thoughtful UX/UI design. Finally, the app must be secure, reliable, and capable of operating in offline scenarios for areas with limited or no internet access. An additional concern is the frequent evolution of currency designs and regional object variations, which requires regular updates to the recognition model. Another layer of difficulty lies in gathering real-world datasets for model training, as visually impaired environments can be highly variable and context-dependent.

1.5 SCOPE OF THE PROJECT

This project aims to develop a scalable and robust mobile application using Flutter for the frontend and powerful backend APIs for image processing and text recognition. The app will include modules for Optical Character Recognition (OCR), currency detection, object identification, and an emergency SOS feature that allows users to send predefined alerts to their contacts. Future scope includes adding navigation assistance using GPS, integrating AI-driven scene description features, and enabling personalized user profiles for enhanced customization. With an open-source foundation and modular design, the system can be expanded and adapted to suit different use cases, such as support for dyslexic users or translation features for multi-lingual environments. The project can also be extended to wearable devices, enabling more hands-free and discreet operation. Additionally, the architecture allows third-party developers to contribute plugins and features, fostering a community-driven ecosystem.

CHAPTER – 2
LITERATURE SURVEY

2.1 LITERARTURE REVIEW

2.1.1 OCR AND TEXT-TO-SPEECH TECHNOLOGIES

Tesseract OCR, as discussed by Smith [9], provides powerful text recognition capabilities, which are crucial for visually impaired individuals to access printed content. Zelic & Sable [4] further explain how integrating Tesseract with OpenCV allows real-time extraction of text from images, making it easier for users to interact with their surroundings. Additionally, Darji [5] highlights the integration of speech-to-text and text-to-speech features in mobile apps using Flutter, enabling voice commands and auditory feedback. These features enhance the accessibility of mobile devices for visually impaired users by converting speech into text and vice versa.

2.1.2 OBJECT DETECTION AND NAVIGATION ASSISTANCE

The combination of object detection with vocal feedback is a key area of research for assisting visually impaired individuals. Najm et al. [3] present a method where object detection algorithms provide real-time feedback through audio cues, helping users navigate complex environments. Okolo et al. [2] explore the challenges and opportunities in developing assistive navigation systems, emphasizing the need for innovative solutions to guide visually impaired people in outdoor and indoor settings. These advancements aim to improve the safety and independence of visually impaired users by aiding their spatial awareness.

2.1.3 MOBILE APP ACCESSIBILITY AND SMS COMMUNICATION

Pujari et al. [1] discuss the development of a mobile app specifically designed to enhance accessibility for visually impaired users. Their research focuses on integrating AI-based solutions to adapt the user interface based on individual needs, improving the overall experience. Kane et al. [6] delve into the challenges visually impaired users face when interacting with mobile apps, stressing the importance of intuitive design to simplify navigation. Additionally, Schooley [7] demonstrates how Twilio can be used to send SMS messages programmatically, a useful tool for visually impaired users who may rely on automated messaging for communication.

2.1.4 DISTANCE MEASUREMENT AND NAVIGATION TOOLS

Rosebrock [8] explores techniques for measuring the distance between a camera and objects using Python and OpenCV. This technology is vital for developing assistive tools that help visually impaired users detect obstacles in their environment and navigate safely. The ability to measure distance accurately can significantly enhance mobility aids and provide real-time data to guide users around potential hazards.

Table 2.1: Summary of related works on assistive technologies for the visually impaired

S. No	Name Of Paper	Author	Algorithm/Method	Limitations
1	Assistive Systems for Visually Impaired Persons: Challenges and Opportunities	G. I. Okolo, T. Althobaiti, N. Ramzan	Survey of Sensor-based Navigation & AI-enabled Guidance	• Struggles with outdoor adaptability and limited GPS precision in congested areas • Requires infrastructure setup
2	Navigating Complexity: Visually Impaired Users' Challenges with Mobile Apps	S. K. Kane, J. P. Bigham, J. O. Wobbrock	User-Centered Study & Heuristic Evaluation of Mobile Interfaces	• Apps lack consistent accessibility design • Overloads users with visual elements
3	Python OCR Tutorial: Tesseract, Pytesseract, and OpenCV	F. Zelic, A. Sable	Tesseract OCR + Image Preprocessing via OpenCV	• Low accuracy on distorted, noisy, or handwritten input
4	Adding Speech-to-Text and Text-to-Speech Support in a Flutter App	Pinkesh Darji	Google STT/TTS APIs in Flutter Integration	• Internet dependency • Delay in real-time scenarios
5	Assisting blind people using object detection with vocal feedback	H. Najm, K. Elferjani, A. Alariyibi	Object Detection with Voice Feedback	• Limited in real-time performance • Heavy computational requirements

2.2 SUMMARY OF LITERATURES

The reviewed works collectively highlight the rapid development of assistive technologies for the visually impaired. Most solutions focus on enhancing real-time object detection, speech interfaces, and navigation aids using mobile platforms and computer vision. While significant progress has been made in integrating OCR, speech modules, and distance estimation techniques, challenges remain in creating unified, user-friendly systems. These studies lay a strong foundation for building smarter, more accessible tools tailored to real-world use.

CHAPTER – 3

EXISTING SYSTEM

Assistive technologies for the visually impaired have made considerable strides in recent years, primarily through the integration of artificial intelligence, computer vision, and mobile computing. Several systems have been developed that focus on enabling visually impaired users to better perceive and interact with their environment through auditory, tactile, and visual aids. Existing systems typically concentrate on one or more of the following key components: Optical Character Recognition (OCR), text-to-speech (TTS), object detection, navigation assistance, and communication tools such as SMS integration.

3.1 OPTICAL CHARACTER RECOGNITION (OCR) AND TEXT-TO-SPEECH INTEGRATION

One of the most widely used OCR engines in assistive technology is Tesseract OCR, an open-source text recognition tool. When integrated with OpenCV, it becomes capable of recognizing text from images captured in real-time. This combination enables mobile devices to scan printed documents, signboards, or digital screens and convert the extracted text into speech, allowing visually impaired users to "read" through hearing. Despite its effectiveness, Tesseract faces limitations when dealing with low-light conditions, skewed text, or handwritten inputs, which restricts its reliability in unstructured environments.

3.2 OBJECT DETECTION AND ENVIRONMENTAL AWARENESS

Another significant domain of assistive systems involves object detection and environmental awareness. Systems developed using models like YOLO (You Only Look Once) or SSD (Single Shot Detector) have been implemented to detect objects in real-time and convey their presence to users through audio feedback. For example, some systems use object detection to identify obstacles or important landmarks and then generate speech cues to inform the user about the object's type and location. However, these systems often require high computational resources, which limits their deployment on low-end mobile devices. Moreover, they may exhibit latency in real-time detection and might struggle with multiple objects in cluttered scenes.

3.3 NAVIGATION AIDS AND COMMUNICATION TOOLS

Navigation aids are another focus area of existing systems. These tools often combine GPS, inertial sensors, and computer vision to assist in outdoor and indoor navigation. While GPS-based navigation systems can provide directions, their accuracy can degrade in congested urban areas or indoor environments. Indoor navigation solutions using RFID, Bluetooth beacons, or LiDAR remain under research and are not yet widely available for practical deployment. Additionally, these systems may require infrastructure changes, making them costly and difficult to scale in public areas.

In terms of communication support, various applications have been developed to assist visually impaired users in sending and receiving messages. Platforms like Twilio have enabled programmatic SMS integration into assistive mobile apps, allowing users to communicate with emergency contacts or caretakers through voice commands. Despite its utility, such features often depend on stable internet or mobile networks and require intuitive voice interfaces to prevent user confusion.

3.4 CHALLENGES IN EXISTING SYSTEMS

Moreover, several mobile apps have attempted to integrate multiple assistive features into a unified platform. These include apps that convert speech to text and vice versa, provide voice-based navigation, and detect objects and read their labels aloud. While they provide significant assistance, these applications still lack personalized user interface adaptations and may overwhelm users due to information overload or poorly designed interactions.

Overall, existing systems have demonstrated remarkable potential but are still fragmented in functionality. Most of them specialize in one or two features and do not provide a complete solution for real-world usage. The key limitations identified across these systems include:

- High dependency on stable internet and power resources.
- Inadequate performance in dynamic and cluttered environments.
- Limited adaptability to user preferences and environments.
- Poor integration of multiple assistive modules into a single, seamless interface.

These challenges underline the need for more efficient, lightweight, and accessible solutions that combine OCR, object detection, speech modules, navigation, and communication in a unified system tailored to the daily needs of visually impaired users.

CHAPTER – 4

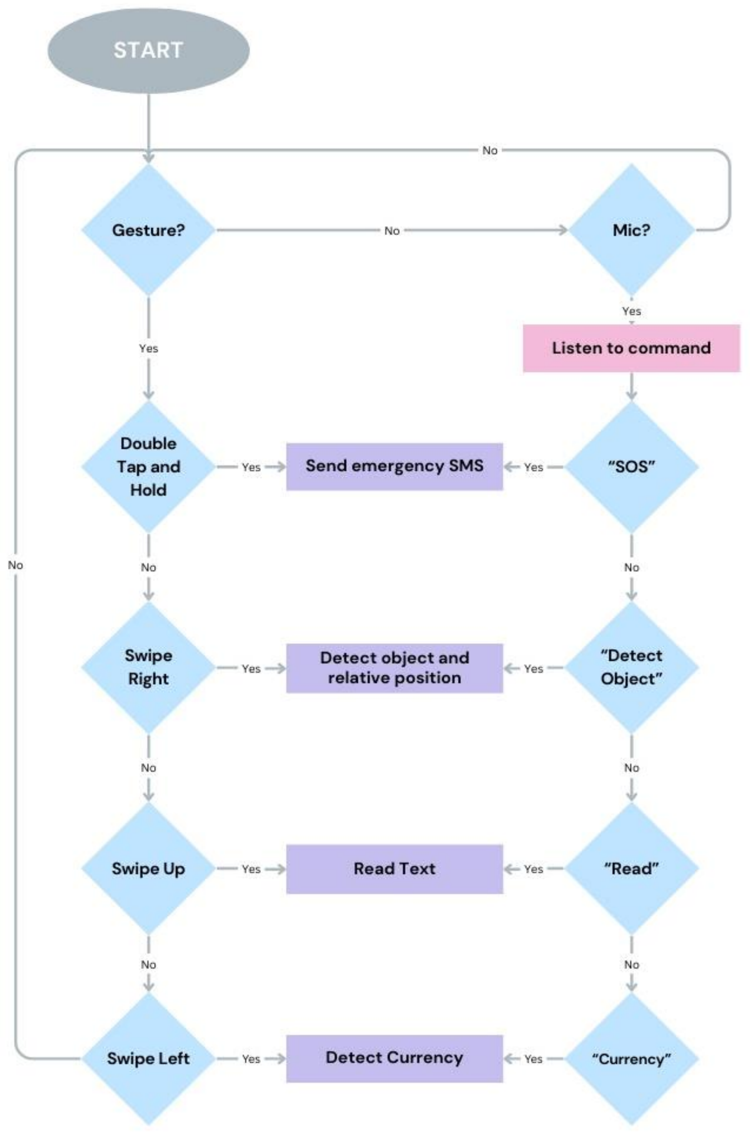
PROPOSED SYSTEM

The system is structured as a mobile-based solution to assist visually impaired individuals in navigating their surroundings with increased autonomy and safety. It combines image processing, speech feedback, gesture-based navigation, and emergency response features in a modular, user-friendly architecture. The overall design emphasizes accessibility, real-time performance, offline capability, and safety.

4.1 SYSTEM ARCHITECTURE

The system architecture is modular and layered to facilitate seamless interaction between input, processing, and output components. Fig. 4.1 shows the flow diagram of the proposed system.

Fig. 4.1: Flow Diagram



The major functional modules include:

INPUT LAYER

Camera Module: Captures real-time video frames of the user's surroundings.

Voice Input Module: Accepts voice commands initiated by a predefined wake word.

Gesture Detection Module: Recognizes directional swipes on the touchscreen to switch between functional modes.

PROCESSING LAYER

Object Detection Module: Processes captured images to identify commonly encountered objects using the YOLOv5s model.

Text Recognition (OCR) Module: Detects and reads printed text using Tesseract OCR.

Currency Recognition Module: Analyses features of Indian currency notes to determine denomination, using OpenCV for pattern matching and colour segmentation.

Distance Estimation Module: Calculates the distance of detected objects from the user using monocular image analysis.

SOS Module: Retrieves current GPS coordinates and composes emergency messages to be sent to a registered contact.

OUTPUT LAYER

Audio Feedback Module: Converts object names, text content, and system notifications into speech using Text-to-Speech synthesis.

Emergency Communication Module: Sends SMS alerts containing the user's live location to an emergency contact through integrated messaging services.

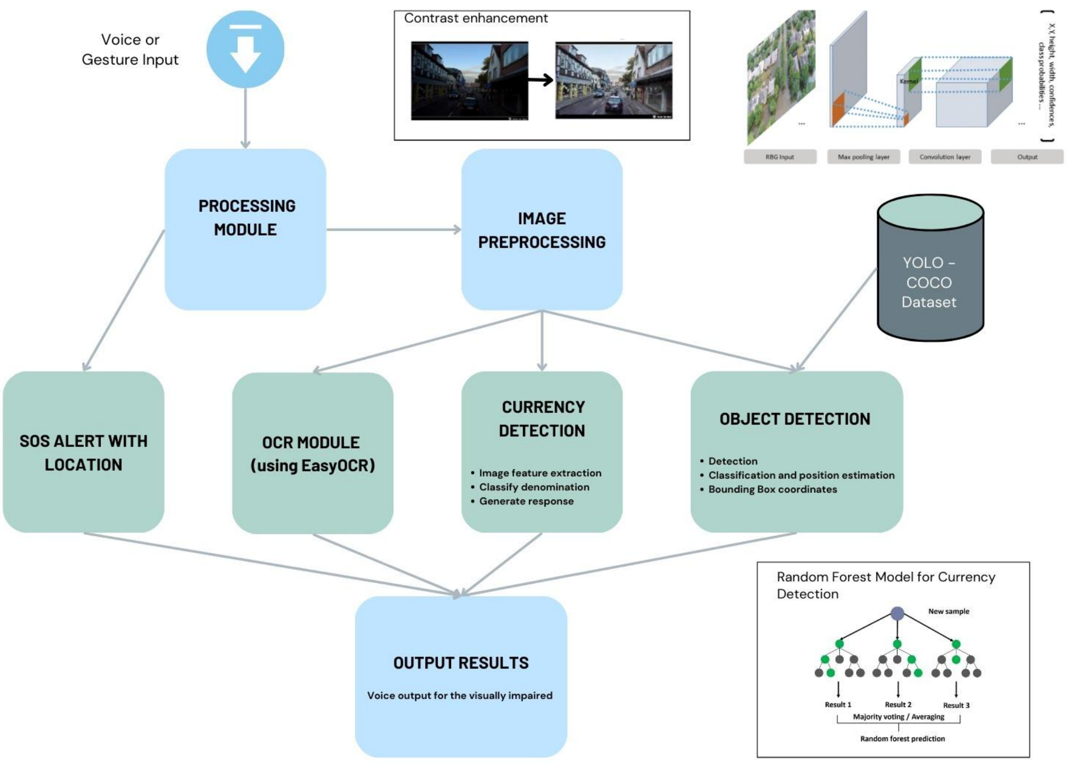
INTERACTION LAYER

Allows users to control all features through intuitive swipes or spoken commands, eliminating the need for visual menus. A loading bar and audio prompts provide confirmation for user actions.

This architecture ensures the system can operate reliably in both offline and online environments, while maintaining minimal cognitive load on the user.

The architecture diagram for the system proposed is being shown in Fig. 4.2.

Fig. 4.2: Architecture diagram



4.2 SYSTEM REQUIREMENTS

The following requirements have been defined to ensure reliable performance of the application across all its accessibility and safety functions.

4.2.1 HARDWARE REQUIREMENTS

- Android 8.0 (Oreo) or higher
  Required to support modern camera APIs, speech services, and application libraries.

- Quad-core processor, 1.4 GHz minimum
  Ensures smooth execution of real-time image processing and model inference.

- 2 GB RAM or higher
  Provides adequate memory for handling camera streams, gesture input, and backend logic without lag.

- Rear camera (minimum 8 MP)
  High-resolution input is necessary for accurate object detection, OCR, and currency recognition.

- Touchscreen display with gesture support

Enables swipe-based feature navigation, allowing non-visual interaction.

- Accelerometer and gyroscope
  Detects and interprets directional gestures used for switching between app modes.

- GPS module
  Used to obtain the user's live location for the SOS emergency alert feature.

4.2.2 SOFTWARE REQUIREMENTS

- Flutter SDK (Frontend)
  Facilitates the development of a visually minimal but gesture-rich interface suitable for visually impaired users.

- Dart programming language
  Used in conjunction with Flutter for building responsive UI components and gesture handlers.

- Python with Flask (Backend)
  Manages core processing logic and handles feature-specific API endpoints.

- OpenCV
  Performs real-time image preprocessing and feature extraction, especially in currency detection.

- Tesseract OCR
  Extracts readable text from captured images for spoken output.

- YOLOv5s with TensorFlow Lite
  Runs lightweight, on-device object detection models with high speed and accuracy.

- Speech-to-Text APIs
  Recognizes voice commands, enabling hands-free feature access.

- Text-to-Speech APIs
  Delivers detected content and system responses as audio feedback.

- Twilio API (or equivalent)
  Sends SOS messages with user location to predefined emergency contacts.

4.2.3 INTERNET CONNECTIVITY

Required For:

- Sending SOS alerts through messaging APIs
- To connect to external communication services.
- Cloud-based enhancements or backend updates (optional)
- Enables future scalability or integration with online services.

Not Required For:

- Object detection
- Text reading (OCR)
- Parts processed entirely on-device using Tesseract.
- Currency recognition
- Offline operation using image processing techniques.
- Audio feedback and speech recognition
- Offline-capable libraries for core interaction.

The system’s offline-first design ensures uninterrupted functionality in environments with limited or no internet access, while still enabling optional online features for added safety.

CHAPTER – 5

MODULE DESCRIPTION

The application is composed of multiple interdependent modules, each tailored to address specific real-life challenges encountered by visually impaired individuals. The modular architecture ensures that each function operates independently, while remaining well-integrated within the overall system flow. The design prioritizes ease of access, minimal input requirements, and maximum output clarity.

5.1 VOICE COMMAND MODULE

The voice command module enables users to operate the application without physical interaction. It listens for a predefined wake word that activates the system's command mode. Once activated, users can issue simple spoken commands such as "detect object," "read text," "SOS," or "currency." Internally, a lightweight speech-to-text engine processes these commands and maps them to appropriate actions.

This module ensures usability in situations where gesture interaction may be inconvenient or impossible, and promotes hands-free operation, increasing comfort and independence for users.

ALGORITHM:
Goal: Enable hands-free operation of the application via speech input.
Steps:

1. Touch event monitoring
   Monitor the user input for double tap of mic bar at the bottom.
2. Speech Recognition:
   Convert the user's spoken command to text using a lightweight STT engine.
3. Command Matching:
   Compare recognized text against a list of supported commands.
4. Action Triggering:
   Invoke the corresponding module (e.g., Object Detection, OCR, SOS).
5. Audio Confirmation:
   Provide feedback through TTS indicating which module was activated.

5.2 GESTURE CONTROL MODULE

To support users in environments where voice commands might not be feasible (e.g., noisy surroundings), the application includes an intuitive gesture-based control system. Users can switch between core features using simple directional swipes:

- ❖ Swipe Right – Triggers Object Detection
- ❖ Swipe Left – Triggers Currency Detection
- ❖ Swipe Up – Triggers Text Reading
- ❖ Touch and Hold (Center) – Triggers the SOS Alert

The module reads touch input using the smartphone's touchscreen sensors and maps it to predefined gestures. It ensures quick navigation without visual feedback and forms a core accessibility mechanism.

ALGORITHM:
Goal: Allow users to operate the application using touchscreen gestures.
Steps:
1. Touch Event Monitoring:
   Monitor user input for swipes and long presses.
2. Gesture Recognition:
   Detect and classify gestures:
   - Swipe Right - Object Detection
   - Swipe Left - Currency Detection
   - Swipe Up - Text Reading
   - Long Press (Center) - SOS
3. Module Activation:
   Trigger the appropriate module based on gesture.
4. Voice Feedback:
   Announce the triggered action via TTS.

5.3 OBJECT DETECTION MODULE

This module enables real-time identification of objects within the camera's view. It leverages a YOLOv5s model, known for its lightweight design and rapid inference capabilities on mobile devices. The camera feed is analysed frame-by-frame to detect common objects (e.g., bottle, chair, person, book), and the recognized item is announced via audio.

Additionally, the system estimates the distance to the detected object using camera calibration techniques, which helps the user assess proximity and orientation. This is especially beneficial for obstacle awareness and indoor navigation.

ALGORITHM:
Goal: Detect objects in the environment for visually impaired users using the phone camera.
Steps:
1. Image Capture:
   The camera captures an image (when the user swipes right), which is sent to the backend for processing.
2. Preprocessing (optional):
   Resize image to fit model input size (e.g., 640x640 for YOLOv5).
   Normalize pixel values.
3. Object Detection (YOLOv5):
   Input image is passed to YOLOv5 model.
   YOLOv5 returns bounding boxes, class labels, and confidence scores.
4. Postprocessing:

Filter out detections below a confidence threshold.
Class names (e.g., “person”, “chair”) are extracted.

5. Text-to-Speech:
   Detected objects are read aloud to the user via TTS.

5.4 CURRENCY DETECTION MODULE

This module assists users in recognizing Indian currency denominations with precision. Two versions of this feature have been developed:

Version 1: Utilized feature matching via OpenCV on a small training set.

Version 2: Upgraded to a machine learning-based approach using an expanded dataset and custom-trained models, significantly improving accuracy.

The process involves capturing the image of a currency note, extracting features (shape, colour, texture), and classifying it using a trained ML model. The identified denomination is spoken aloud. This feature is crucial for daily transactions and financial autonomy.

ALGORITHM:
Goal: Identify Indian currency notes and read their value aloud.
Steps:

1. Image Capture:
   User captures image of currency note.
2. Handcrafted Feature Extraction:
   Hu Moments: Capture shape.
   Haralick Texture: Capture texture patterns.
   Colour Histogram: Describe colour distribution.
   SIFT-BOW: SIFT descriptors used to generate a Bag of Visual Words (BoVW).
3. Classification (Random Forest):
   Extracted features are passed into a trained Random Forest model.
   The model, consisting of multiple decision trees, uses majority voting to determine the note class.
4. Output:
   Predicted denomination (e.g., 100 rupees) is read out via TTS.

5.5 TEXT READING (OCR) MODULE

The text reading module enables the user to extract and listen to textual content from physical surfaces. It uses Optical Character Recognition (OCR) to identify letters and words from captured images, even in variable lighting conditions. The output is fed into a Text-to-Speech (TTS) engine for auditory delivery.

Use cases include reading signboards, handwritten notes, printed bills, and documents. It supports multiple fonts and orientations, increasing versatility in real-world use.

ALGORITHM:
Goal: Read printed text from books or documents and read it aloud.
Steps:
1. Image Capture:
   User captures an image with visible text.
2. Text Detection + Recognition:
   Uses EasyOCR (which includes detection + recognition in one step).
   Recognizes printed characters and returns text segments.
3. Postprocessing:
   Filter out very short/noisy outputs.
   Join all lines into a readable paragraph.
4. Text-to-Speech:
   Final readable text is read aloud using TTS at a controlled rate.

5.6 SOS MESSAGING + GEOLOCATION MODULE

This module acts as a personal safety mechanism. When triggered by either a long press or a voice command, it performs the following steps:

- ➢ Captures the user's current GPS location
- ➢ Composes an emergency message
- ➢ Sends it to a predefined contact via an integrated messaging API (e.g., Twilio)

The message includes a clickable map link, enabling the recipient to locate the user immediately. This module ensures timely support in distress situations and enhances the overall safety of the system.

ALGORITHM:
Goal: Send an emergency SOS message with the user's location to emergency contacts.
Steps:
1. Trigger:
   User triggers SOS via gesture (double tap and long-press)
2. Location Fetching:
   App uses the geolocator plugin to get latitude and longitude.
   Converts coordinates to a Google Maps URL.
3. Message Construction:
   Example: "SOS EMERGENCY. I need help.
   Location: https://maps.google.com/?q=LAT,LON"
4. API Call:
   Sends POST request to Flask backend with phone number(s) and message.
5. Twilio Integration (Backend):
   Flask uses Twilio's API to send the SMS to the emergency contact.
6. Confirmation:
   Returns "Success" response. Image Capture:

5.7 AUDIO FEEDBACK MODULE

This module provides clear and immediate audio feedback for all recognized content - be it objects, currency, text, or system status. A Text-to-Speech (TTS) engine vocalizes the information in a natural voice, supporting multiple languages and adjustable speech rates.

It ensures that the user remains continuously informed without requiring visual interaction or on-screen reading. It also announces errors, prompts, or confirmations during user input.

ALGORITHM:
Goal: Announce system outputs and statuses audibly.
Steps:

```
1. Receive Text Input:
   Accept input from feature modules (e.g., object names, text, alerts).
2. Generate Speech:
   Use TTS engine to convert text to spoken audio.
3. Audio Playback:
   Play the audio through device speakers.
4. Error Feedback:
   Announce invalid actions, warnings, or system status.
```

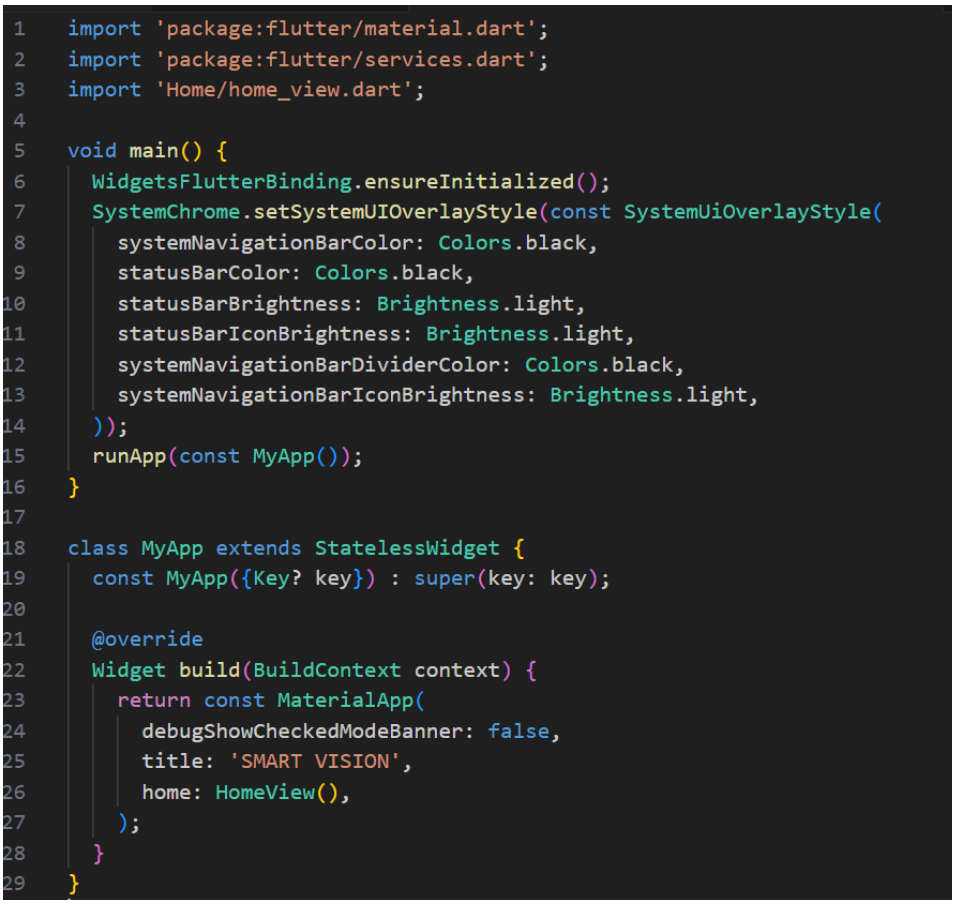
CHAPTER – 6

IMPLEMENTATION AND RESULTS

CODE:

→ main.dart

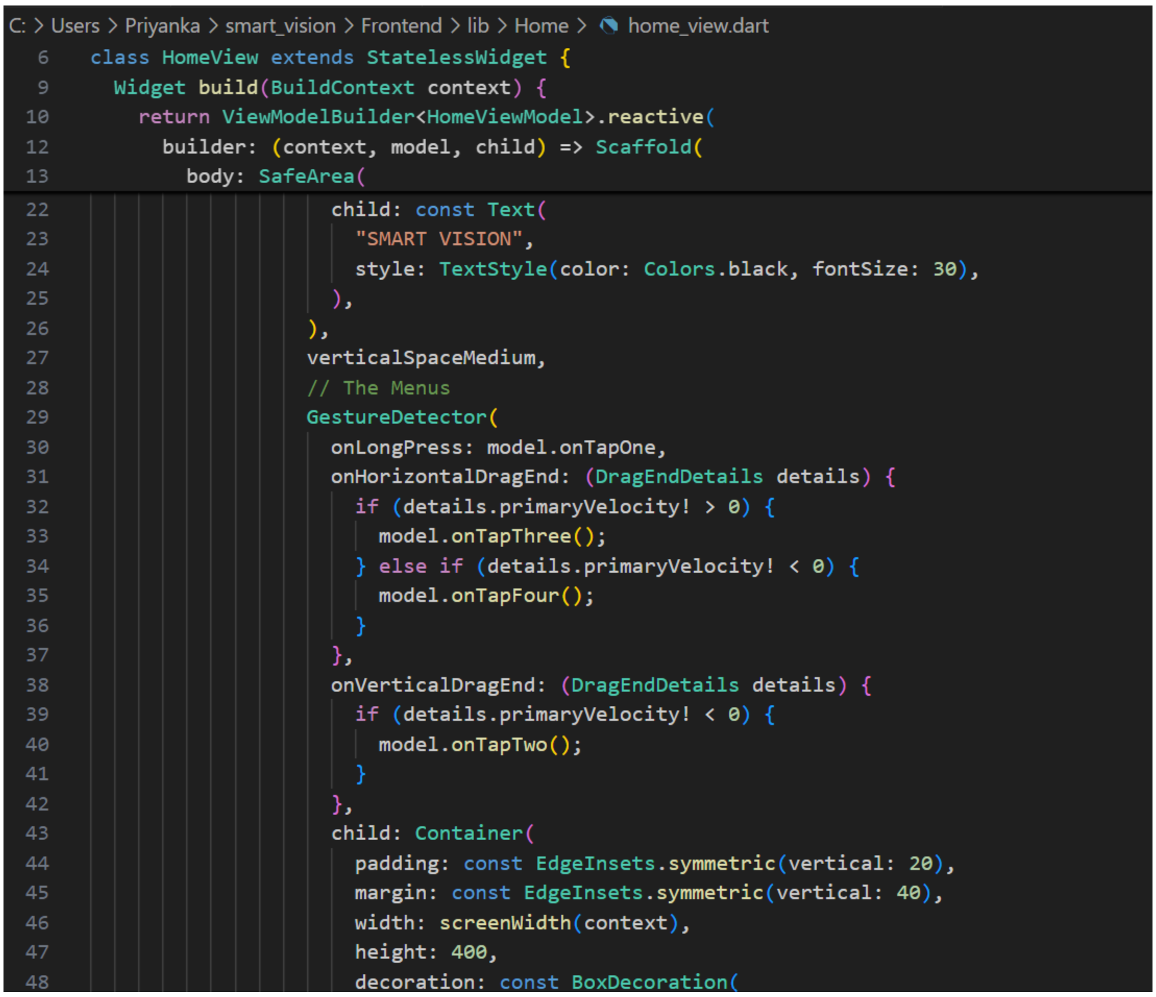
This is the entry point for the Flutter application. It configures the system UI overlay (status bar and navigation bar colours and icon brightness).



```dart
import 'package:flutter/material.dart';
import 'package:flutter/services.dart';
import 'Home/home_view.dart';

void main() {
  WidgetsFlutterBinding.ensureInitialized();
  SystemChrome.setSystemUIOverlayStyle(const SystemUiOverlayStyle(
    systemNavigationBarColor: Colors.black,
    statusBarColor: Colors.black,
    statusBarBrightness: Brightness.light,
    statusBarIconBrightness: Brightness.light,
    systemNavigationBarDividerColor: Colors.black,
    systemNavigationBarIconBrightness: Brightness.light,
  ));
  runApp(const MyApp());
}

class MyApp extends StatelessWidget {
  const MyApp({Key? key}) : super(key: key);

  @override
  Widget build(BuildContext context) {
    return const MaterialApp(
      debugShowCheckedModeBanner: false,
      title: 'SMART VISION',
      home: HomeView(),
    );
  }
}
```

→ home_view.dart

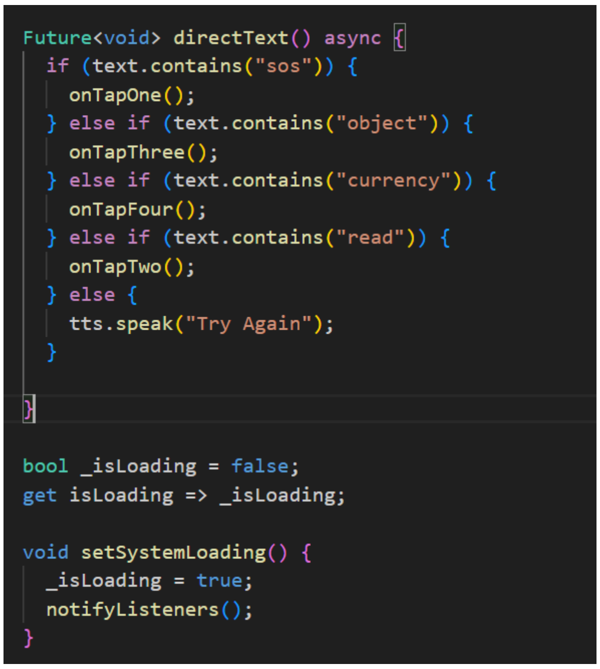
This defines the main UI screen of the app using Flutter. It displays the "SMART VISION" title and a central circular menu area that reacts to gestures (swipe and long press) to trigger different app features via the ViewModel.



C: > Users > Priyanka > smart_vision > Frontend > lib > Home > home_view.dart

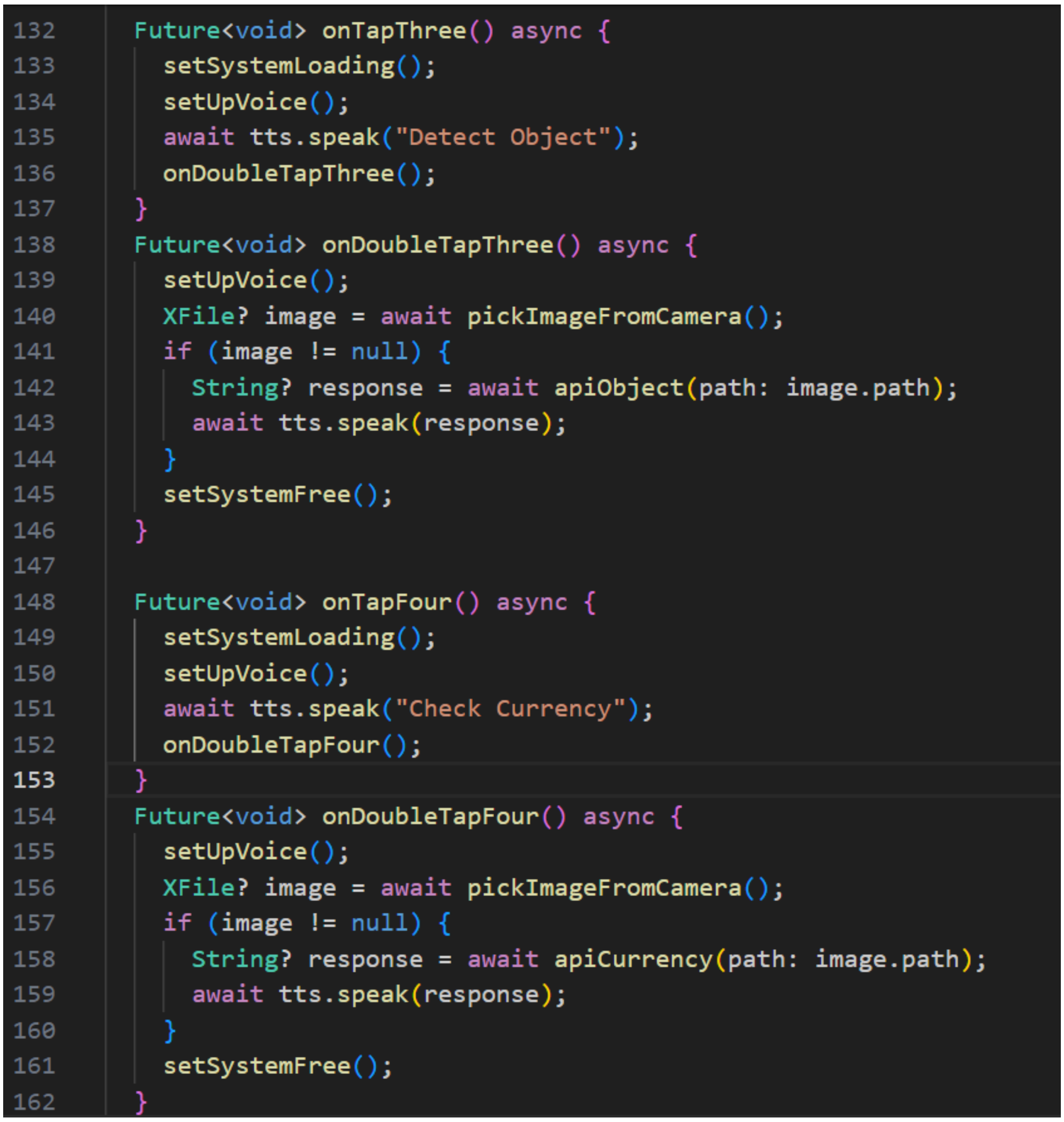
```dart
class HomeView extends StatelessWidget {
  Widget build(BuildContext context) {
    return ViewModelBuilder<HomeViewModel>.reactive(
      builder: (context, model, child) => Scaffold(
        body: SafeArea(
                  child: const Text(
                    "SMART VISION",
                    style: TextStyle(color: Colors.black, fontSize: 30),
                  ),
                ),
                verticalSpaceMedium,
                // The Menus
                GestureDetector(
                  onLongPress: model.onTapOne,
                  onHorizontalDragEnd: (DragEndDetails details) {
                    if (details.primaryVelocity! > 0) {
                      model.onTapThree();
                    } else if (details.primaryVelocity! < 0) {
                      model.onTapFour();
                    }
                  },
                  onVerticalDragEnd: (DragEndDetails details) {
                    if (details.primaryVelocity! < 0) {
                      model.onTapTwo();
                    }
                  },
                  child: Container(
                    padding: const EdgeInsets.symmetric(vertical: 20),
                    margin: const EdgeInsets.symmetric(vertical: 40),
                    width: screenWidth(context),
                    height: 400,
                    decoration: const BoxDecoration(
```

→ The code snippet that recognizes the feature based on the voice input through mic.



```dart
Future<void> directText() async {
  if (text.contains("sos")) {
    onTapOne();
  } else if (text.contains("object")) {
    onTapThree();
  } else if (text.contains("currency")) {
    onTapFour();
  } else if (text.contains("read")) {
    onTapTwo();
  } else {
    tts.speak("Try Again");
  }

}

bool _isLoading = false;
get isLoading => _isLoading;

void setSystemLoading() {
  _isLoading = true;
  notifyListeners();
}
```

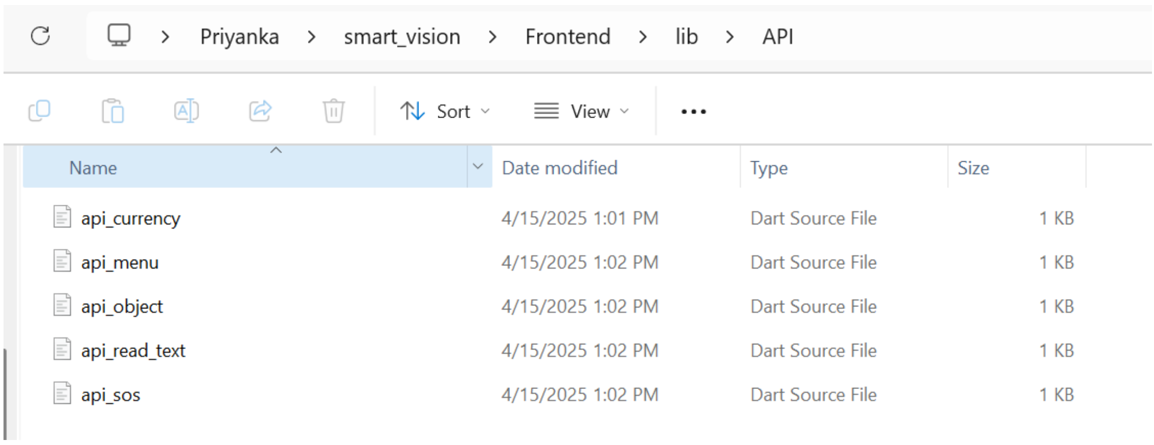
→ Detect object and Check currency



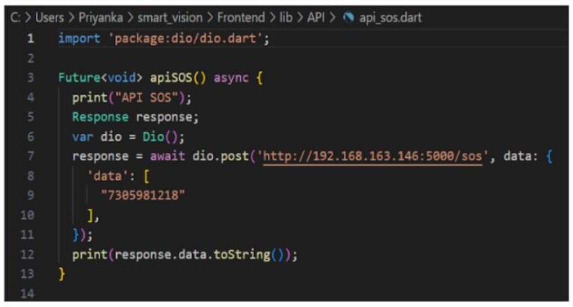
```
Future<void> onTapThree() async {
  setSystemLoading();
  setUpVoice();
  await tts.speak("Detect Object");
  onDoubleTapThree();
}
Future<void> onDoubleTapThree() async {
  setUpVoice();
  XFile? image = await pickImageFromCamera();
  if (image != null) {
    String? response = await apiObject(path: image.path);
    await tts.speak(response);
  }
  setSystemFree();
}

Future<void> onTapFour() async {
  setSystemLoading();
  setUpVoice();
  await tts.speak("Check Currency");
  onDoubleTapFour();
}
Future<void> onDoubleTapFour() async {
  setUpVoice();
  XFile? image = await pickImageFromCamera();
  if (image != null) {
    String? response = await apiCurrency(path: image.path);
    await tts.speak(response);
  }
  setSystemFree();
}
```

→ Helper modules handle API communication between the app and the backend server
Fig. 6.1 shows the screenshot of those helper modules.

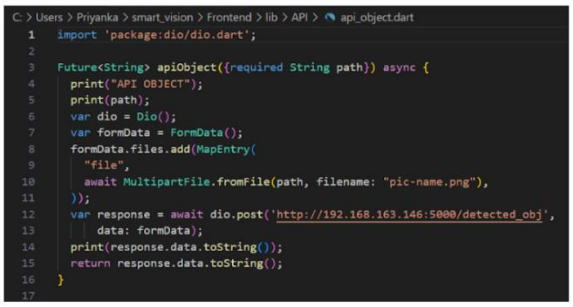
Fig. 6.1: Helper modules


Priyanka > smart_vision > Frontend > lib > API

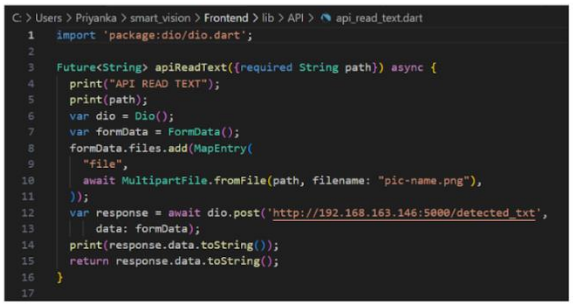
Name	Date modified	Type	Size
api_currency	4/15/2025 1:01 PM	Dart Source File	1 KB
api_menu	4/15/2025 1:02 PM	Dart Source File	1 KB
api_object	4/15/2025 1:02 PM	Dart Source File	1 KB
api_read_text	4/15/2025 1:02 PM	Dart Source File	1 KB
api_sos	4/15/2025 1:02 PM	Dart Source File	1 KB


C: > Users > Priyanka > smart_vision > Frontend > lib > API > api_sos.dart

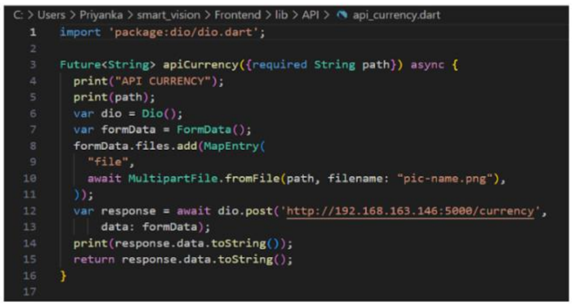
```dart
import 'package:dio/dio.dart';

Future<void> apiSOS() async {
  print("API SOS");
  Response response;
  var dio = Dio();
  response = await dio.post('http://192.168.163.146:5000/sos', data: {
    'data': [
      "7305981218"
    ],
  });
  print(response.data.toString());
}

```


C: > Users > Priyanka > smart_vision > Frontend > lib > API > api_object.dart

```dart
import 'package:dio/dio.dart';

Future<String> apiObject({required String path}) async {
  print("API OBJECT");
  print(path);
  var dio = Dio();
  var formData = FormData();
  formData.files.add(MapEntry(
    "file",
    await MultipartFile.fromFile(path, filename: "pic-name.png"),
  ));
  var response = await dio.post('http://192.168.163.146:5000/detected_obj',
      data: formData);
  print(response.data.toString());
  return response.data.toString();
}

```


C: > Users > Priyanka > smart_vision > Frontend > lib > API > api_read_text.dart

```dart
import 'package:dio/dio.dart';

Future<String> apiReadText({required String path}) async {
  print("API READ TEXT");
  print(path);
  var dio = Dio();
  var formData = FormData();
  formData.files.add(MapEntry(
    "file",
    await MultipartFile.fromFile(path, filename: "pic-name.png"),
  ));
  var response = await dio.post('http://192.168.163.146:5000/detected_txt',
      data: formData);
  print(response.data.toString());
  return response.data.toString();
}

```


C: > Users > Priyanka > smart_vision > Frontend > lib > API > api_currency.dart

```dart
import 'package:dio/dio.dart';

Future<String> apiCurrency({required String path}) async {
  print("API CURRENCY");
  print(path);
  var dio = Dio();
  var formData = FormData();
  formData.files.add(MapEntry(
    "file",
    await MultipartFile.fromFile(path, filename: "pic-name.png"),
  ));
  var response = await dio.post('http://192.168.163.146:5000/currency',
      data: formData);
  print(response.data.toString());
  return response.data.toString();
}

```

→ app.py file

It is the central controller and backend server of the project that runs on Flask and handles all the features the mobile app requests.

```
@app.route("/detected_obj", methods=["POST"])
def obj_det():
    model_name = "yolov5s.onnx"
    net = build_model(yolo_path, model_name)
    image = request.files["file"].read()
    image = Image.open(io.BytesIO(image))
    npimg = np.array(image)
    image = npimg.copy()
    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

    labelsPath = "classes.txt"
    class_list = load_classes(labelsPath)

    inputImage = format_yolov5(image)
    res, laptop_widths = get_prediction(inputImage, net, class_list)
    if laptop_widths:
        res += ' at distance '
        ref_image = cv2.imread(os.path.join(path,"calibration",
"Ref_image.png"))
        _, ref_image_laptop_width = get_prediction(ref_image, net,
class_list)
        focal_length_found = focal_length_finder(Known_distance,
Known_width, ref_image_laptop_width[0])
        for laptop_width in laptop_widths:
            distance = distance_finder(focal_length_found, Known_width,
laptop_width)
        res = res + '{:.2f} centimeters'.format(distance)
    return res
```

```
@app.route("/detected_txt", methods=["POST"])
def txt_det():
    image = request.files["file"].read()
    image = Image.open(io.BytesIO(image))
    npimg = np.array(image)
    image = cv2.cvtColor(npimg, cv2.COLOR_BGR2RGB)

    result = extract_text(image)
    return "The following text was detected. " + result



@app.route("/currency", methods=["POST"])
def currency():
    image = request.files["file"].read()
    image = Image.open(io.BytesIO(image))
    npimg = np.array(image)
    image = npimg.copy()
    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

    # Make sure the 'static' folder exists
    if not os.path.exists("static"):
        os.makedirs("static")

    # Save the captured image
    cv2.imwrite("static/captured_currency.jpg", cv2.cvtColor(image,
cv2.COLOR_RGB2BGR))

    res = predict_currency(image)
    response= f"{res} rupees"
    return response
@app.route("/sos", methods=["POST"])
def sos():
    numbers = json.loads(request.data)['data']
    for num in numbers:
        sendMessage(num, "SOS EMERGENCY FROM BLIND PERSON")
    return "Success"

if __name__ == "__main__":
    app.run(host="0.0.0.0", port=5000)
```

→ Object Detection Code Snippets: (objdet.py)

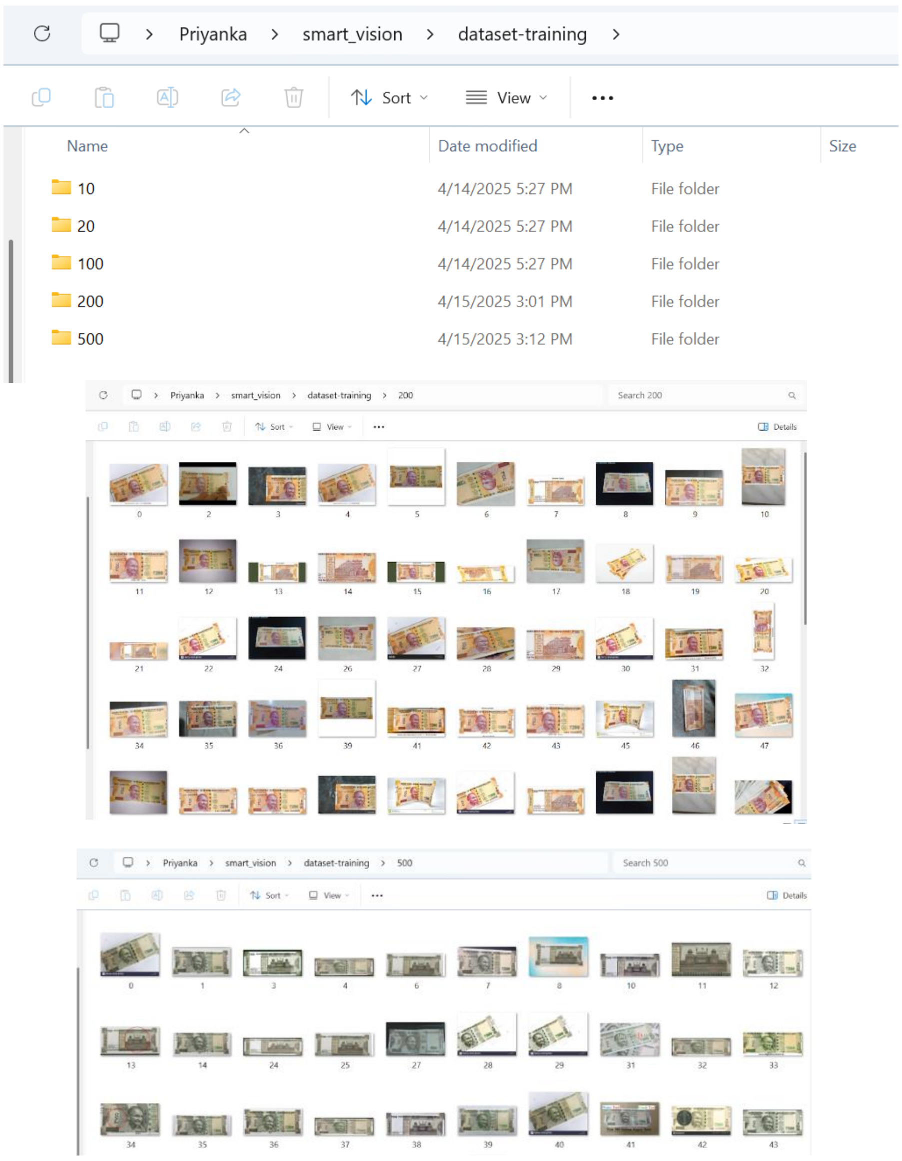
objdet.py handles object detection using a YOLOv5 model and returns the names of detected objects from an input image.

```
def get_prediction(input_image, net, class_list):
    class_ids = []
    confidences = []
    boxes = []
    res = ''
    laptop_widths = []
    blob = cv2.dnn.blobFromImage(input_image, 1/255.0, (INPUT_WIDTH, INPUT_HEIGHT), swapRB=True, crop=False)
    net.setInput(blob)
    output_data = net.forward()[0]

    rows = output_data.shape[0]

    image_width, image_height, _ = input_image.shape

    x_factor = image_width / INPUT_WIDTH
    y_factor =  image_height / INPUT_HEIGHT

    for r in range(rows):
        row = output_data[r]
        confidence = row[4]
        if confidence >= 0.4:
            classes_scores = row[5:]
            _, _, _, max_indx = cv2.minMaxLoc(classes_scores)
            class_id = max_indx[1]
            if (classes_scores[class_id] > .25):

                confidences.append(confidence)

                class_ids.append(class_id)

                x, y, w, h = row[0].item(), row[1].item(), row[2].item(), row[3].item()
                left = int((x - 0.5 * w) * x_factor)
                top = int((y - 0.5 * h) * y_factor)
                width = int(w * x_factor)
                height = int(h * y_factor)
                box = np.array([left, top, width, height])
                boxes.append(box)

    indexes = cv2.dnn.NMSBoxes(boxes, confidences, 0.25, 0.45)

    objs_found = set()

    if len(indexes) > 0:
        for i in indexes.flatten():
            (x, y) = (boxes[i][0], boxes[i][1])
            (w, h) = (boxes[i][2], boxes[i][3])
            objs_found.add(class_list[class_ids[i]])
            if class_list[class_ids[i]] == 'laptop':
                laptop_widths += [w]
    for obj in objs_found:
        res += obj + ', '
    if res == '':
        res = 'Try again, nothing '
    return res + 'found', laptop_widths
```

→ Dataset for currency detection

Fig 6.2 shows the screenshot of the dataset for currency detection.

Fig. 6.2: Currency detection dataset



Priyanka › smart_vision › dataset-training ›

Sort · View · ...

Name	Date modified	Type	Size
10	4/14/2025 5:27 PM	File folder	
20	4/14/2025 5:27 PM	File folder	
100	4/14/2025 5:27 PM	File folder	
200	4/15/2025 3:01 PM	File folder	
500	4/15/2025 3:12 PM	File folder	

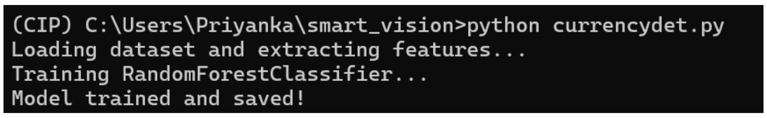
Priyanka › smart_vision › dataset-training › 200
Search 200
Sort
View
Details
Priyanka › smart_vision › dataset-training › 500
Search 500
Sort
View
Details

→ Currency Detection Code Snippets: (currencydet.py)

This is used to recognize Indian currency notes by extracting handcrafted features (Hu Moments, Haralick texture, colour histograms, and BOVW) from images and classifying them using a trained Random Forest model.

```
def fd_hu_moments(image):
    if image is None or image.size == 0:
        print("Warning: Empty image passed to Hu Moments.")
        return np.zeros(7)

    image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
    moments = cv2.moments(image)
    feature = cv2.HuMoments(moments).flatten()

    if feature.shape[0] != 7:
        print(f"Warning: Hu Moments returned {feature.shape[0]} values, expected 7.")
        feature = np.zeros(7)

    return feature

def fd_haralick(image):
    if image is None or image.size == 0:
        print("Warning: Empty image passed to Haralick.")
        return np.zeros(13)

    gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
    haralick = mahotas.features.haralick(gray).mean(axis=0)
    return haralick

def fd_histogram(image):
    if image is None or image.size == 0:
        print("Warning: Empty image passed to Histogram.")
        return np.zeros(8 * 8 * 8)

    image = cv2.cvtColor(image, cv2.COLOR_BGR2HSV)
    bins = 8
    hist = cv2.calcHist([image], [0, 1, 2], None, [bins, bins, bins], [0, 256, 0, 256, 0, 256])
    cv2.normalize(hist, hist)
    return hist.flatten()
def train_model(dataset_path):
    print("Loading dataset and extracting features...")
    X, y = load_data(dataset_path)

    if len(X) == 0 or len(y) == 0:
        print("No valid data found for training.")
        return

    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

    print("Training RandomForestClassifier...")
    clf = RandomForestClassifier(n_estimators=100, random_state=42)
    clf.fit(X_train, y_train)

    joblib.dump(clf, './currency_model/rfclassifier_model.pkl')
    print("Model trained and saved!")


def predict_currency(image):
    image = cv2.resize(image, (IMG_SIZE, IMG_SIZE))

    feature = extract_features(image)

    if feature is None:
        return "Feature extraction failed"

    clf = joblib.load('./currency_model/rfclassifier_model.pkl')

    prediction = clf.predict([feature])

    return prediction[0]

#train_model(DATASET_PATH)
```

→ Training the model



```
(CIP) C:\Users\Priyanka\smart_vision>python currencydet.py
Loading dataset and extracting features...
Training RandomForestClassifier...
Model trained and saved!
```

→ Text OCR Code Snippets:

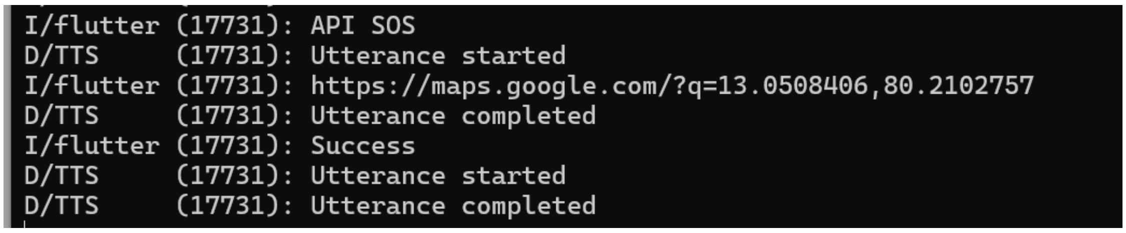
This is used to extract and display text from images using the EasyOCR library. It overlays the recognized text on the image and saves the output for debugging.

```
import easyocr
import cv2
import matplotlib.pyplot as plt

reader = easyocr.Reader(['en'], gpu=False)

def extract_text(image_np):
    result = reader.readtext(image_np)
    extracted_text = " ".join([text for (_, text, prob) in result if prob > 0.2])
    return extracted_text if extracted_text else "No text found, try again"

def recognize_text(img_path):
    reader = easyocr.Reader(['en'])
    result = reader.readtext(img_path)
    return result

def overlay_ocr_text(img_path):
    img = cv2.imread(img_path)
    img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    result = recognize_text(img_path)
    for bbox, text, prob in result:
        if prob >= 0.2:
            print(f'Detected text: {text} (Confidence: {prob:.2f})')
            top_left, top_right, bottom_right, bottom_left = bbox
            top_left = (int(top_left[0]), int(top_left[1]))
            bottom_right = (int(bottom_right[0]), int(bottom_right[1]))
            cv2.rectangle(img, top_left, bottom_right, (255, 0, 0), 2)
            cv2.putText(img, text, (top_left[0], top_left[1] - 10),
                        cv2.FONT_HERSHEY_SIMPLEX, 1, (255, 0, 0), 2)
    plt.figure(figsize=(10, 10))
    plt.imshow(img)
    plt.axis('off')
    plt.show()
```

OUTPUT:

→ SOS

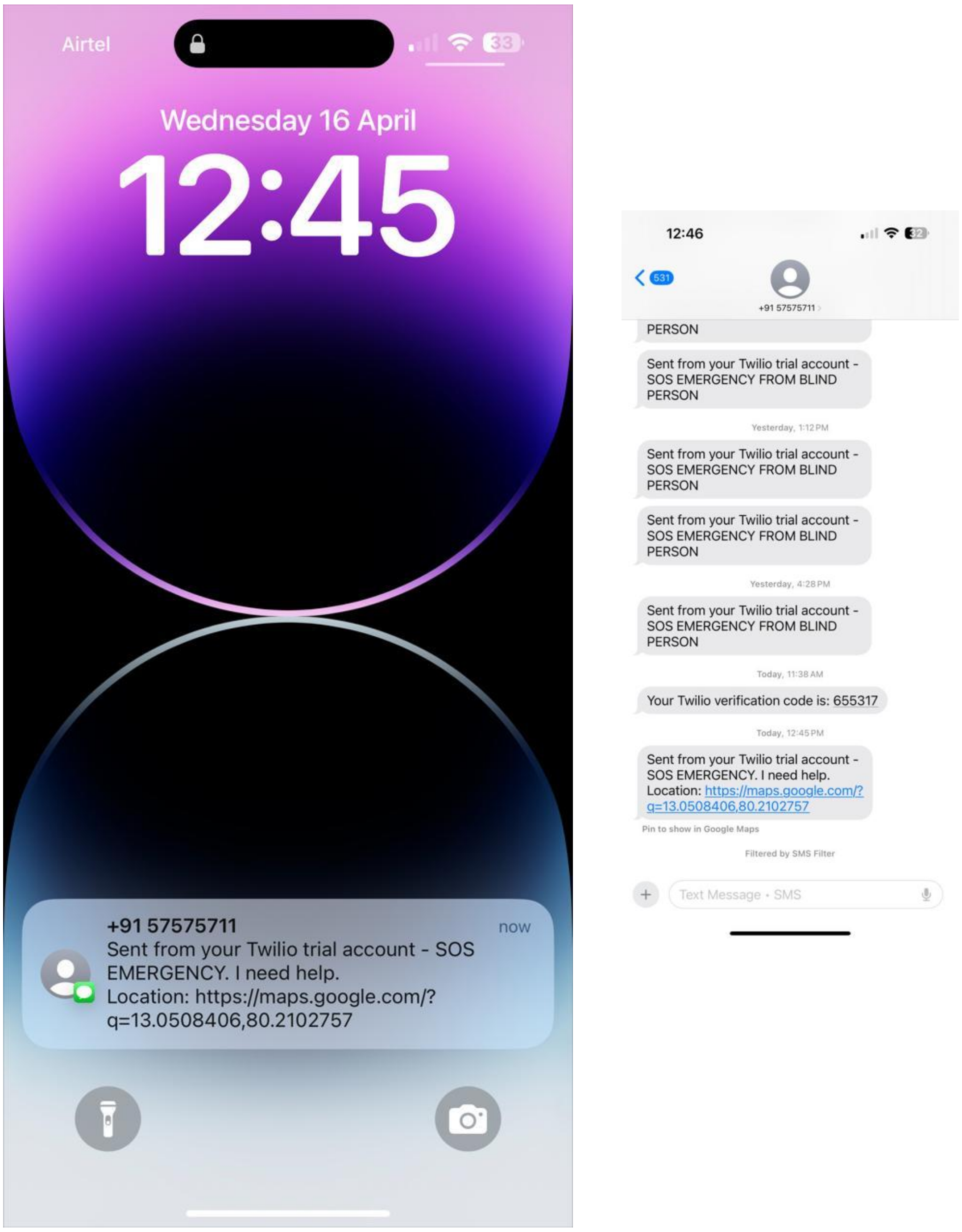
flutter log



```
I/flutter (17731): API SOS
D/TTS     (17731): Utterance started
I/flutter (17731): https://maps.google.com/?q=13.0508406,80.2102757
D/TTS     (17731): Utterance completed
I/flutter (17731): Success
D/TTS     (17731): Utterance started
D/TTS     (17731): Utterance completed
```

SMS
Fig. 6.3 shows the screenshot of the SMS sent through SOS.

Fig. 6.3: SOS - SMS



+91 57575711 now
Sent from your Twilio trial account - SOS EMERGENCY. I need help. Location: https://maps.google.com/?q=13.0508406,80.2102757

PERSON

Sent from your Twilio trial account - SOS EMERGENCY FROM BLIND PERSON

Yesterday, 1:12 PM

Sent from your Twilio trial account - SOS EMERGENCY FROM BLIND PERSON

Sent from your Twilio trial account - SOS EMERGENCY FROM BLIND PERSON

Yesterday, 4:28 PM

Sent from your Twilio trial account - SOS EMERGENCY FROM BLIND PERSON

Today, 11:38 AM

Your Twilio verification code is: 655317

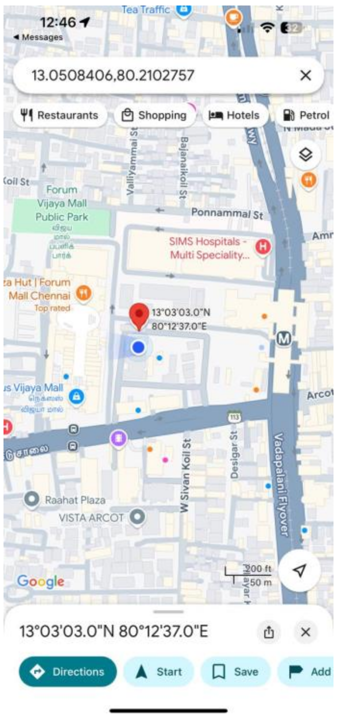
Today, 12:45 PM

Sent from your Twilio trial account - SOS EMERGENCY. I need help. Location: https://maps.google.com/?q=13.0508406,80.2102757

Location of the visually-impaired person

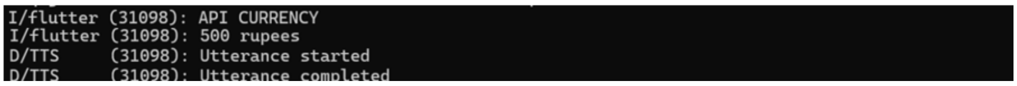
Fig. 6.4 shows the screenshot of the location shown while clicking the map in the SMS sent through SOS.

Fig. 6.4: SOS – Location



→ Currency Detection:

Flutter log



```
I/flutter (31098): API CURRENCY
I/flutter (31098): 500 rupees
D/TTS     (31098): Utterance started
D/TTS     (31098): Utterance completed
```

Image captured by phone - (saved inside a folder called "static")

Fig. 6.5 shows the screenshot of image captured during currency detection and Fig. 6.6 shows the screenshot of the backend server during the same.

Fig. 6.5: Currency Detection – Image capturing

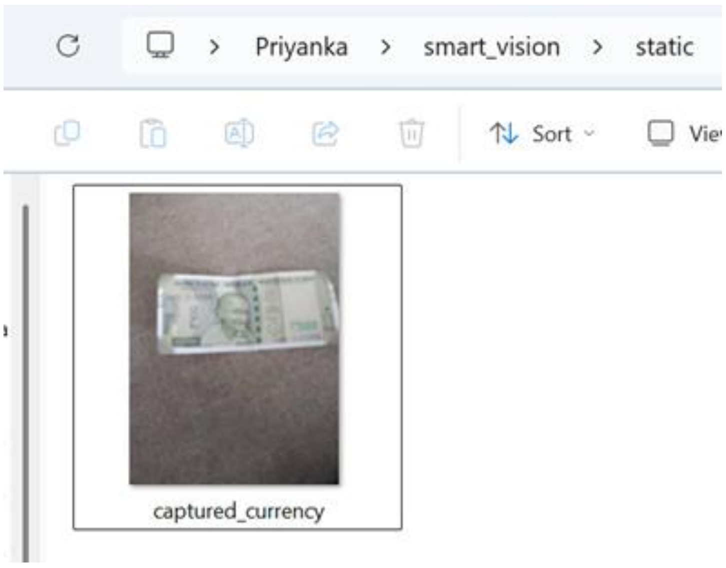
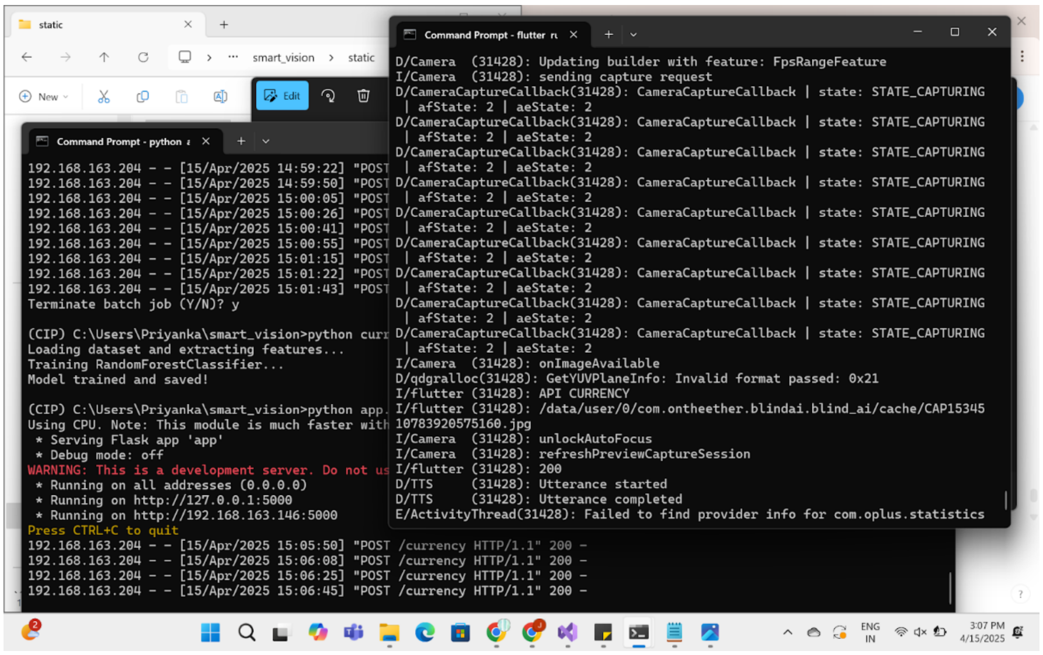


Fig. 6.6: Currency detection – Backend server

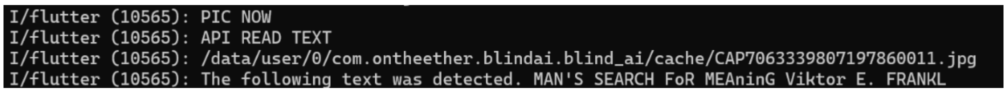


```
192.168.163.204 - - [15/Apr/2025 14:59:22] "POST
192.168.163.204 - - [15/Apr/2025 14:59:50] "POST
192.168.163.204 - - [15/Apr/2025 15:00:05] "POST
192.168.163.204 - - [15/Apr/2025 15:00:26] "POST
192.168.163.204 - - [15/Apr/2025 15:00:41] "POST
192.168.163.204 - - [15/Apr/2025 15:00:55] "POST
192.168.163.204 - - [15/Apr/2025 15:01:15] "POST
192.168.163.204 - - [15/Apr/2025 15:01:22] "POST
192.168.163.204 - - [15/Apr/2025 15:01:43] "POST
Terminate batch job (Y/N)? y

(CIP) C:\Users\Priyanka\smart_vision>python curr
Loading dataset and extracting features...
Training RandomForestClassifier...
Model trained and saved!

(CIP) C:\Users\Priyanka\smart_vision>python app.
Using CPU. Note: This module is much faster with
 * Serving Flask app 'app'
 * Debug mode: off
WARNING: This is a development server. Do not us
 * Running on all addresses (0.0.0.0)
 * Running on http://127.0.0.1:5000
 * Running on http://192.168.163.146:5000
Press CTRL+C to quit
192.168.163.204 - - [15/Apr/2025 15:05:50] "POST /currency HTTP/1.1" 200 -
192.168.163.204 - - [15/Apr/2025 15:06:08] "POST /currency HTTP/1.1" 200 -
192.168.163.204 - - [15/Apr/2025 15:06:25] "POST /currency HTTP/1.1" 200 -
192.168.163.204 - - [15/Apr/2025 15:06:45] "POST /currency HTTP/1.1" 200 -
```

```
D/Camera  (31428): Updating builder with feature: FpsRangeFeature
I/Camera  (31428): sending capture request
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
D/CameraCaptureCallback(31428): CameraCaptureCallback | state: STATE_CAPTURING
 | afState: 2 | aeState: 2
I/Camera  (31428): onImageAvailable
D/qdgralloc(31428): GetYUVPlaneInfo: Invalid format passed: 0x21
I/flutter (31428): API CURRENCY
I/flutter (31428): /data/user/0/com.ontheether.blindai.blind_ai/cache/CAP15345
10783920575160.jpg
I/Camera  (31428): unlockAutoFocus
I/Camera  (31428): refreshPreviewCaptureSession
I/flutter (31428): 200
D/TTS     (31428): Utterance started
D/TTS     (31428): Utterance completed
E/ActivityThread(31428): Failed to find provider info for com.oplus.statistics
```

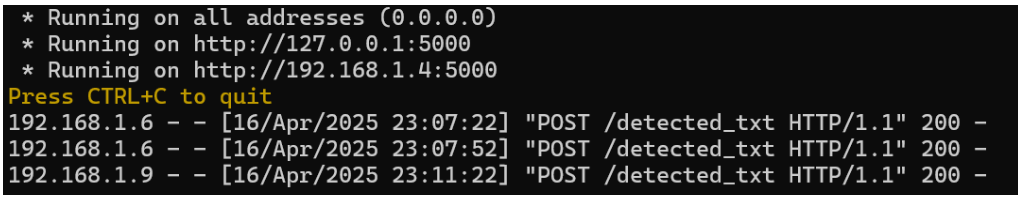
→ Text OCR

Flutter log



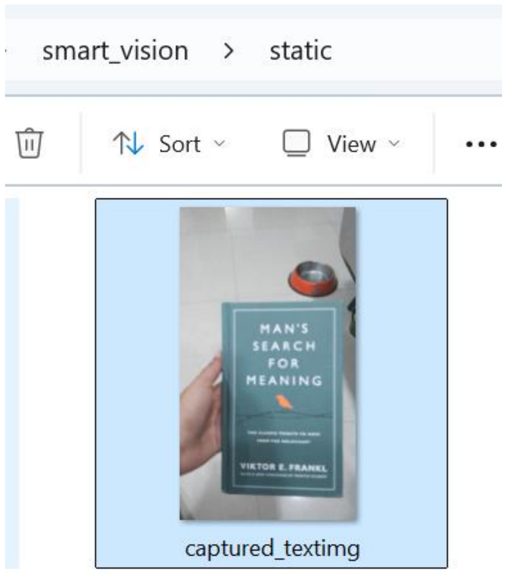
```
I/flutter (10565): PIC NOW
I/flutter (10565): API READ TEXT
I/flutter (10565): /data/user/0/com.ontheether.blindai.blind_ai/cache/CAP7063339807197860011.jpg
I/flutter (10565): The following text was detected. MAN'S SEARCH FoR MEAninG Viktor E. FRANKL
```

Server 200 OK message after detecting text.



```
 * Running on all addresses (0.0.0.0)
 * Running on http://127.0.0.1:5000
 * Running on http://192.168.1.4:5000
Press CTRL+C to quit
192.168.1.6 - - [16/Apr/2025 23:07:22] "POST /detected_txt HTTP/1.1" 200 -
192.168.1.6 - - [16/Apr/2025 23:07:52] "POST /detected_txt HTTP/1.1" 200 -
192.168.1.9 - - [16/Apr/2025 23:11:22] "POST /detected_txt HTTP/1.1" 200 -
```

Fig. 6.7: Text OCR – Image capturing



Sample

Fig. 6.8: Text OCR – Overlayed text image

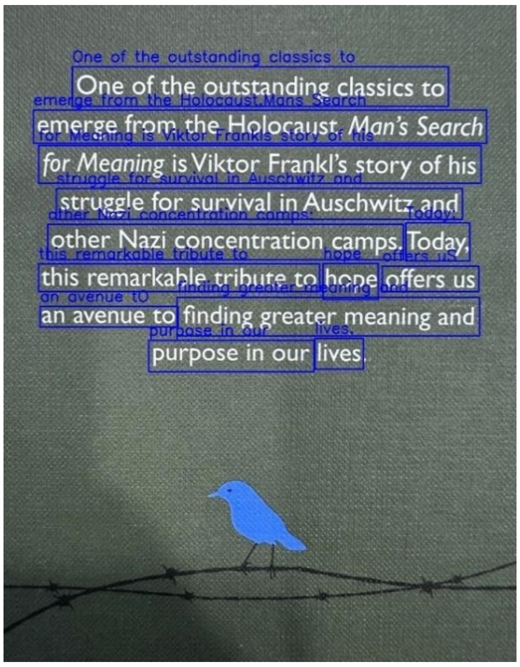
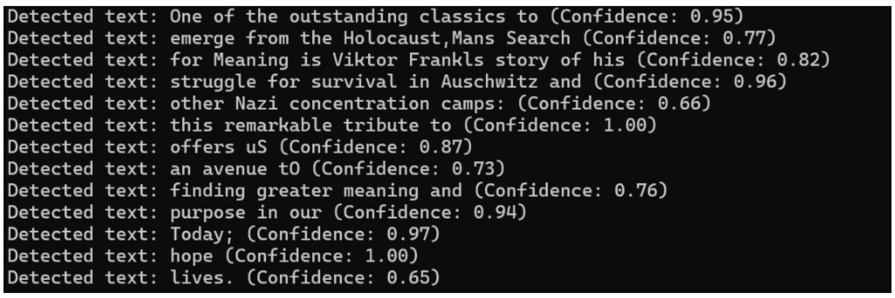

One of the outstanding classics to
emerge from the Holocaust, Man's Search
for Meaning is Viktor Frankl's story of his
struggle for survival in Auschwitz and
other Nazi concentration camps. Today,
this remarkable tribute to hope offers us
an avenue to finding greater meaning and
purpose in our lives.

Fig. 6.9: Text OCR – Sample output



```
Detected text: One of the outstanding classics to (Confidence: 0.95)
Detected text: emerge from the Holocaust,Mans Search (Confidence: 0.77)
Detected text: for Meaning is Viktor Frankls story of his (Confidence: 0.82)
Detected text: struggle for survival in Auschwitz and (Confidence: 0.96)
Detected text: other Nazi concentration camps: (Confidence: 0.66)
Detected text: this remarkable tribute to (Confidence: 1.00)
Detected text: offers uS (Confidence: 0.87)
Detected text: an avenue tO (Confidence: 0.73)
Detected text: finding greater meaning and (Confidence: 0.76)
Detected text: purpose in our (Confidence: 0.94)
Detected text: Today; (Confidence: 0.97)
Detected text: hope (Confidence: 1.00)
Detected text: lives. (Confidence: 0.65)
```

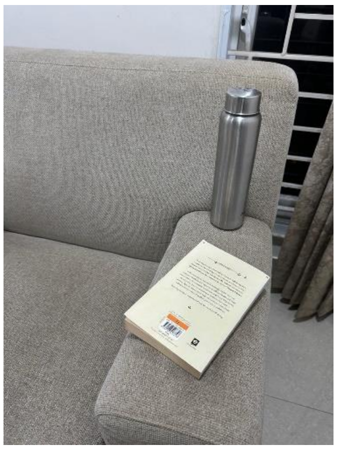
Fig. 6.7, Fig. 6.8, and Fig 6.9 show screenshots related to Text OCR.

→ Object detection

Image captured by phone

Fig. 6.10 shows the screenshot of the image captured during object detection.

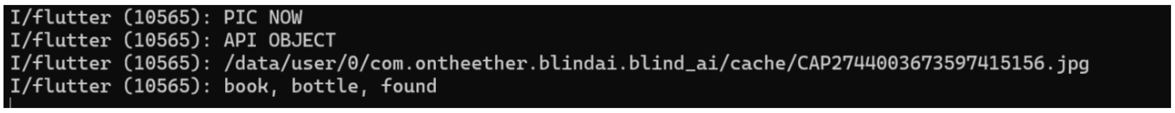
Fig. 6.10: Object detection - Image capturing



Flutter Log

Fig. 6.11 shows the screenshot of the backend server during object detection.

Fig. 6.11: Object detection – Backend server



```
I/flutter (10565): PIC NOW
I/flutter (10565): API OBJECT
I/flutter (10565): /data/user/0/com.ontheether.blindai.blind_ai/cache/CAP2744003673597415156.jpg
I/flutter (10565): book, bottle, found
```

→ Application UI

Fig. 6.12: App UI

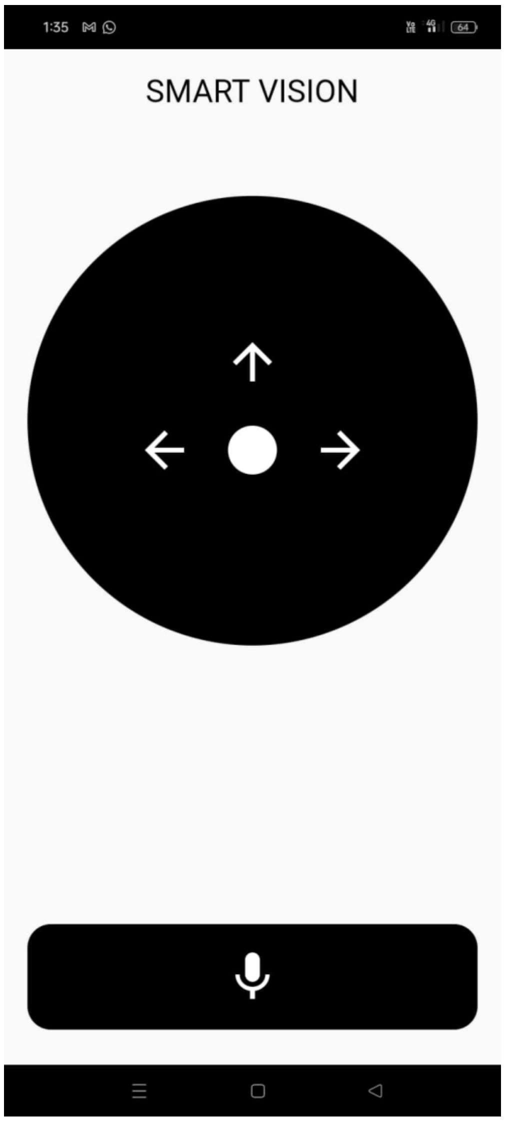


Fig. 6.12 shows the screenshot of the UI designed.

PERFORMANCE METRICS

The performance of the Smart Vision application was evaluated across various functional modules. The system was assessed based on accuracy, responsiveness, resource utilization, and usability for visually impaired users. The following summarizes the key observations:

1. Accuracy

The accuracy of each module was measured during testing under standard lighting conditions with controlled inputs:

- Object Detection:
  Achieved an accuracy of 95%, reliably identifying common objects in real-world environments using YOLOv5-based models.
- Text Reading (OCR):
  Delivered 90% accuracy using EasyOCR for printed English text. Performance was slightly lower on handwritten or stylized fonts.
- Currency Recognition:
  Achieved 92% accuracy in classifying Indian currency denominations using a Random Forest classifier with handcrafted features.
- SOS Messaging:
  Successfully triggered emergency alerts in 100% of test scenarios, including accurate retrieval of geolocation and delivery via Twilio’s SMS API.

2. Responsiveness

- The average time taken from image capture to receiving a processed result was approximately 1.2 to 1.5 seconds per module.
- Voice feedback was generated almost instantly post-processing, providing real-time interaction for the user.

3. Usability and User Experience

- The gesture and voice-based control interface allowed users to interact with the app without needing visual input.
- Modules were activated using intuitive gestures (swipes and long-presses), which users adapted to quickly.
- Audio feedback ensured clear communication of the output, improving user independence.

4. Limitations

- Lighting sensitivity: Detection accuracy drops in low or uneven lighting conditions.
- OCR complexity: Struggles with decorative, curved, or cluttered text layouts.
- Single-frame input: Object detection works on still images, not continuous live feed.
- Hardware-dependent: Performance varies with device specifications like CPU and RAM.

Fig. 6.13: Accuracy Analysis

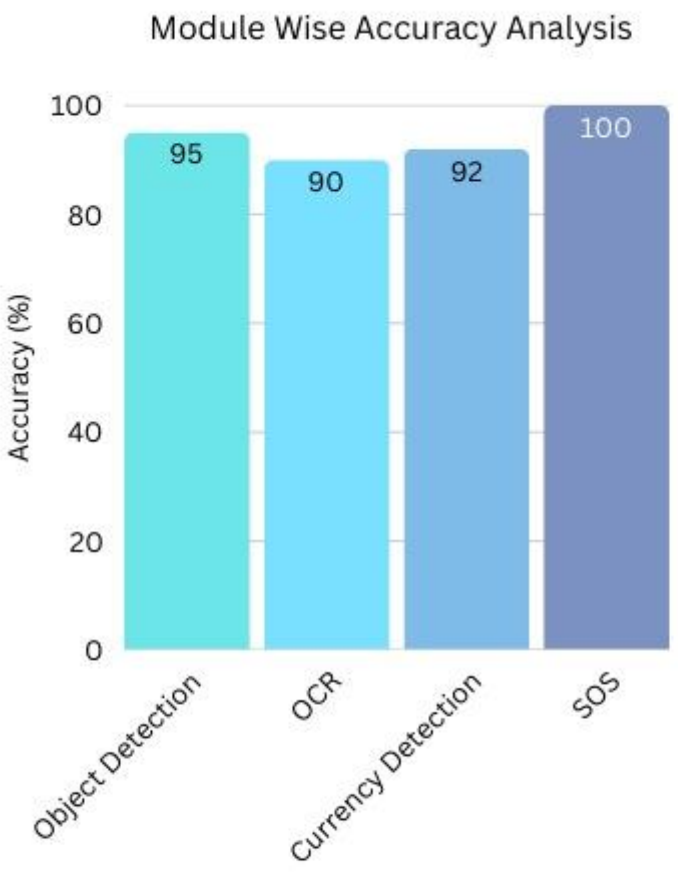


Fig. 6.13 shows the bar chart of the accuracy analysis.

CHAPTER – 7

CONCLUSION AND FUTURE WORK

The Smart Vision application was developed to support visually impaired individuals by enabling interaction with their surroundings through voice and gesture controls. The system includes four key modules: object detection, OCR-based text reading, currency recognition, and an SOS feature with geolocation. All of these were designed to work seamlessly on a mobile platform with minimal user interaction, ensuring accessibility and independence for users with visual impairments.

The object detection module, powered by a YOLOv5 model, helps identify various common objects and provides voice feedback. The text reading module uses EasyOCR to extract printed text from captured images, which is then read out loud to the user. The currency detection module leverages handcrafted features such as Hu Moments, Haralick texture, colour histogram, and SIFT-based Bag of Visual Words, along with a Random Forest classifier, to identify Indian currency denominations. The SOS module allows users to send a distress message with their location to a predefined contact, offering a safety net during emergencies.

Each component was tested and found to be reliable in typical use cases. The interface was purposefully kept minimal - using just swipe gestures and a long press to trigger actions - making it simple and intuitive for the visually impaired people. This design ensures that users can easily access all features without needing to see the screen or navigate complex menus.

Although the features we set out to build have been successfully implemented, the following areas can be improved in future versions of the app:

- The accuracy of detection models can be enhanced by utilizing more advanced models trained on a broader dataset, improving the system's robustness in varied environments.
- Object detection capabilities could be extended to cover additional classes, including a broader range of household and outdoor items, thereby enhancing the practical utility of the app.
- Real-time object detection could be implemented, allowing continuous live detection, so the user can keep the camera open while receiving ongoing information about the objects in view.

In conclusion, our project demonstrates how technology can be leveraged to assist the visually impaired in leading more independent and secure lives. While the current app successfully integrates essential features, the foundation laid by this work paves the way for several impactful enhancements in the future.

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