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IRIS: Intelligent Real-Time Information System - A Voice-First, On-Device Android Assistant for Visually Impaired Users

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Abstract : *This paper presents IRIS, an Intelligent Real-Time Informa-tion System: a voice-first Android assistant designed to give visually impaired people real-time awareness of their surroundings. Visually impaired people mostly rely on white canes, Braille and screen readers, which detect only nearby obstacles or work only with prepared con-tent, while existing smart-glasses and single-purpose applications are expensive, hardware-dependent and scattered across many tools. To address this issue, the proposed system combines scene description, text reading, currency identification, recognition of familiar faces, ob-stacle alerts, spoken navigation and SOS alerts in a single smartphone application. A four-layer architecture, consisting of a user interface layer, an application logic layer, a core modules layer and a hardware layer, runs the core artificial intelligence on the device, with a command router linking the speech, vision, emergency and navigation services. Audio and haptic feedback make the system hands-free and real-time, while an SOS command sends an SMS with the live location and calls a caretaker. The system is therefore low-cost, accessible and runs on an ordinary smartphone. This paper presents the literature survey, problem identification, proposed system, system requirements and system design of IRIS.*

Keywords: Assistive technology, visually impaired, on-device AI, voice assistant, obstacle detection, face recognition, OCR, Android.

I. INTRODUCTION

Independent movement and access to information are basic hu-man needs, yet for visually impaired people they are often a daily challenge. According to World Health Organization (WHO) esti-mates, over 285 million people are visually impaired, and about 39 million of them are blind. Navigating unfamiliar places, reading signs and printed text, recognising people and handling currency remain difficult without help from another person, and such help is not always available.

Traditional aids such as the white cane, guide dogs, Braille and screen readers have supported visually impaired people for many years, but they give little real-time awareness of the surroundings. A cane detects only nearby obstacles, and Braille and screen readers work only with prepared content. Dedicated smart-glasses and sensor devices provide more information, but they are expensive and depend on special hardware.

Advances in artificial intelligence (AI), optical character recognition (OCR), speech technology and smartphones now make low-cost assistive tools possible. A modern smartphone provides a camera, microphone, speaker, GPS and vibration motor in one device, and lightweight neural networks can run directly on it. IRIS builds on this idea to combine scene de-scription, text reading, currency identification, face recognition, obstacle alerts, navigation and emergency help in one always-on, voice-driven mobile assistant.

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The main objective of this work is to improve the indepen-dence and safety of visually impaired people through an afford-able, voice-first Android application that gives real-time informa-tion about the surroundings and allows hands-free control using only a standard smartphone. The specific objectives are:

- to provide hands-free control of all features through speech-to-text (STT) and spoken results through text-to-speech (TTS);
- to describe the scene and read printed text aloud from the live camera feed;
- to identify currency notes and recognise familiar faces using on-device models;
- to detect obstacles from the live camera and warn the user through haptic (vibration) and audio feedback;
- to provide spoken navigation to a destination using Google Maps;
- to provide a one-command SOS alert that sends an SMS with the live location and automatically calls a caretaker; and
- to design a four-layer architecture with a command router that links the speech, vision, emergency and navigation services, with core AI processing running on the device.

II. LITERATURE SURVEY

Jeong et al. [1] apply YOLOv8 object detection with XR-based navigation on smart glasses and test it on a real-world outdoor walking dataset. Detection of obstacles and signage is accurate, but the system lacks OCR and recognition of known people. Hemamalini et al. [2] propose an IoT and AI framework that combines obstacle detection, face and emotion recognition, OCR and TTS on a custom prototype; it is multi-functional but suffers from latency and limited scalability. The blind campus naviga-tion system of [3] combines GPS positioning, obstacle detection and TTS-based guidance and works well for campus navigation, but has no OCR or AR support. Two hardware prototypes, a belt and a stick, are compared in [4] using a laboratory-tested sensor dataset; detection accuracy is high, but the devices are hardware-only with no AI or advanced recognition.

Bamdad et al. [5] survey simultaneous localisation and map-ping (SLAM) approaches for visually impaired navigation, giv-ing a strong theoretical foundation but no practical implemen- tation or evaluation. Binoy et al. [6] integrate RFID, a camera and TTS to announce bus information to blind passengers; it was tested in bus-stop trials and is limited to that scenario. Zen et al.

[7] perform a systematic literature mapping of more than 108 works on assistive technology, giving a broad analysis of trends and gaps but no prototype.

AIDEN [8] is a smartphone app that uses AI for scene descrip-tion and question answering, OCR and object finding, but heavy models such as YOLO and LLaVA run on a central server, which increases latency. Kambham and Varman [9] detect obstacles such as vehicles, animals and people in the user's path and warn the user by voice, using a DepthNet module with convolutional LSTM layers. Whisper [10] trains a transformer encoder-decoder on 680,000 hours of multilingual web audio and is robust to ac-cents, noise and languages, but it is heavy for on-device use and adds latency. Masud et al. [11] describe an assistive system that avoids obstructions through object detection and classification, and Connier et al. [12] study perception assistance through smart objects, with a concept, an implementation and an experiment scenario.

A group of recent works [13–19] addresses iris biometrics: end-to-end learning of discriminative iris textures [13], infant iris recognition with near-infrared images [14], hybrid U-Net and ResNet segmentation under eyelid and eyelash occlusion [15], failure analysis of vision foundation models for open-set presen-tation attack detection [16], transformer-based iris verification with Siamese learning [17], electromagnetic side-channel leak-age from near-infrared iris sensors [18], and privacy-preserving iris matching with fully homomorphic encryption [19]. These studies are not assistive systems themselves, but they highlight the privacy and security aspects that matter for any system that handles biometric data, such as the known-face database in IRIS. Finally, Tapu et al. [20] survey wearable assistive devices and vision-based approaches and highlight open issues of cost, us-ability and real-time performance.

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A. Existing Systems and Their Disadvantages

Existing assistive systems follow several approaches. The white cane and guide dogs detect only nearby obstacles and give no in-formation on objects, signs or people. Braille and screen readers are limited to prepared content and cannot read the surrounding text. Smart glasses and sensor devices are expensive, hardware-dependent and offer limited recognition. Separate single-purpose applications force users to switch between OCR, navigation and object detection tools. GPS-only navigation has coarse accuracy and no obstacle awareness. Emergency help is rarely integrated, and multi-function prototypes suffer from latency.

B. Problem Statement

Although assistive technology for visually impaired people has advanced, most existing solutions are not practical for every-day independent living. The main problems identified from the literature survey are:

- Limited awareness: canes, Braille and screen readers give little real-time information about obstacles, objects, signs and people.
- Single-purpose solutions: obstacle-only or hardware-only solutions lack OCR and person recognition, and features such as OCR, navigation and detection are scattered across separate applications.
- Cost and latency: smart glasses and sensor devices are ex-pensive and hardware-dependent, and cloud-based or multi-function prototypes suffer from latency.
- Emergency help not integrated: calling for help hands-free with a live location is rarely integrated into assistive tools.

Therefore, there is a need for an affordable, unified, real-time system that helps visually impaired people understand obstacles, objects, people and text, navigate, and call for help hands-free.

III. DESIGN

A. Proposed System

IRIS is a voice-first Android application that gives visually im-paired users real-time information about their surroundings using only a smartphone. Its main components are:

- Voice command: hands-free control of all features using STT and TTS.
- Describe and read: scene captioning using a TensorFlow Lite (TFLite) model and text reading using ML Kit.
- Currency and faces: identification of currency notes, and recognition of known people using MobileFaceNet with a Room database of known faces.
- Obstacle alerts: live camera feed using CameraX with ML Kit obstacle detection and haptic feedback.
- Navigate: spoken directions to a destination using Google Maps.
- SOS alert: an SMS with the live location and an automatic call to a caretaker.
- Command router: a router in the application logic layer that maps spoken commands to the speech, vision, emergency and navigation services and routes the results back to the user.

The advantages of this approach are hands-free operation, real-time awareness through live obstacle detection and face recogni-tion, fast and private on-device AI, a one-command SOS with live location, and affordability, since everything runs on an ordi-nary smartphone.

B. System Requirements

The system runs on an ordinary Android smartphone and does not require special sensors or external devices. The hardware requirements are an Android 9.0 or higher device with an octa-core processor of 2.0 GHz or higher, at least 4 GB RAM (6 GB recommended), 64 GB storage, a rear camera of 12 MP or higher, a microphone, speaker, GPS and vibration motor, and Wi-Fi or 4G connectivity. The software stack comprises Kotlin and Android Studio, CameraX for

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the live feed, TFLite and ML Kit for vision AI, MobileFaceNet with a Room database for face recognition, Android STT and TTS for speech, Google Maps for navigation, and GPS, SMS and auto-call for safety.

C. System Architecture

The architecture of IRIS has four layers, as shown in Fig. 1. The User Interface Layer is the Android application, with the features

TABLE I: COMPARISON OF KEY ASSISTIVE-TECHNOLOGY LITERATURE

Ref.	Year	Methodology	Advantages	Limitations
[1]	2024	YOLOv8 with XR-based navigation on smart glasses	Accurate real-time obstacle and signage detection	No OCR or known-person recognition
[2]	2025	AI-IoT framework: obstacle, face and emotion recognition, OCR, TTS	Multiple functions in one system	Latency; limited scalability
[3]	2024	GPS, obstacle detection, TTS guidance	Independent campus navigation	No OCR or AR support
[4]	2023	Belt-based and stick-based sensor prototypes	Comparative obstacle-detection assessment	Hardware only; no AI recognition
[5]	2022	Survey of SLAM methods	Strong theoretical foundation	No implementation or evaluation
[6]	2024	RFID, camera and TTS announcements	Accessible bus and route information	Limited to public transport
[7]	2023	Systematic mapping of 108+ works	Broad overview of trends and gaps	No prototype
[8]	2026	YOLO and LLaVA on a server; OCR, scene description, Q&A	Several vision functions in one app	Server dependence increases latency
[9]	2024	DepthNet with ConvLSTM and voice alerts	Audio obstacle warnings	Depends on detection accuracy
[10]	2023	Transformer trained on 680k hours of audio	Robust multilingual speech recognition	Heavy for on-device use
[11]	2022	Object detection and classification for obstruction avoidance	Supports obstacle awareness for the user	Limited implementation and evaluation detail
[12]	2020	Smart objects for perception assistance (concept, implementation, experiment)	Shows how smart objects can support perception	Limited technical and experimental detail
[13]	2026	DF-Iris: end-to-end learning of discriminative iris textures	Robust iris features under partial occlusion	Biometric only; not an assistive system
[14]	2025	Near-infrared infant iris recognition with specialised segmentation	Privacy-aware infant identification research	Biometric only; long-term reliability unclear
[15]	2025	Hybrid U-Net and ResNet iris segmentation	Handles eyelid and eyelash occlusion	Preprocessing stage only
[16]	2026	Failure analysis of vision foundation models for iris attack detection	Reveals weaknesses against unseen attacks	Not an assistive system
[17]	2026	Vision Transformer with	Accurate iris verification	High computational complexity

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		attention-guided segmentation and Siamese learning		
[18]	2026	Electromagnetic side-channel analysis of near-infrared iris sensors	Highlights hardware-level risks	privacyPractical attack conditions limited
[19]	2026	Fully homomorphic encryption with PCA on iris codes	Privacy-preserving template comparison	Added computational overhead
[20]	2020	Survey of wearable and vision-based devices	Identifies open challenges	Cost, usability and real-time issues remain

Voice Command, Describe & Read, Currency, Face Recognition, Navigate and SOS Alert. The Application Logic Layer contains the Command Router, which maps spoken commands to features and routes the results back to the user, and the Speech, Vision, Emergency and Navigation services.

The Core Modules Layer performs the on-device processing: the Speech Module (STT and TTS), Continuous AI (CameraX live feed, MobileFaceNet faces, Room database of known faces, ML Kit obstacles and the haptic controller), On-demand AI (TFLite captioning, ML Kit text reading and currency detec-tion) and Safety & Location (GPS positioning, auto-call to the caretaker and SMS with live location). Google Maps and the caretaker phone are external. The Hardware Layer is the smart-phone with its microphone, speaker, vibration motor, camera and GPS module.

D. Data Flow Diagrams

Data flow diagrams (DFDs) represent the flow of information through the system, showing how inputs such as voice commands and the camera view are processed and returned to the user as spoken results and haptic alerts.

D.1 DFD Level 0

The Level 0 (context) diagram in Fig. 2 gives a high-level overview of IRIS without internal processing details. The user (a visually impaired person) provides voice commands and the camera view to the IRIS system, represented as a single process. The system returns spoken results and haptic alerts to the user, exchanges route requests and route data with Google Maps, and sends the SOS SMS with live location and the automatic call to the caretaker phone.

D.2 DFD Level 1

The Level 1 DFD in Fig. 3 breaks the system into eight processes:

- **Voice Command Processing (1.0):** converts the spoken com-mand to text and routes it to the required service using the command router.
- **Describe and Read (2.0):** generates a scene description and reads text from the camera frame.
- **Currency Detection (3.0):** identifies the currency note shown to the camera.
- **Face Recognition (4.0):** recognises known people by com-paring faces with the known-faces database (D1).
- **Obstacle Detection (5.0):** detects obstacles in the live camera feed and triggers alerts.
- **Navigation (6.0):** obtains route data from Google Maps and prepares spoken directions.
- **SOS Emergency (7.0):** builds the alert with the live location, sends the SMS and calls the caretaker.
- **Audio and Haptic Output (8.0):** speaks the results and gives vibration feedback to the user.

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IV. CONCLUSION

This work on IRIS has identified the limited real-time awareness provided by canes, Braille and screen readers, and the practi-cal limitations of expensive hardware-based and single-purpose assistive solutions. A survey of 20 research papers shows that

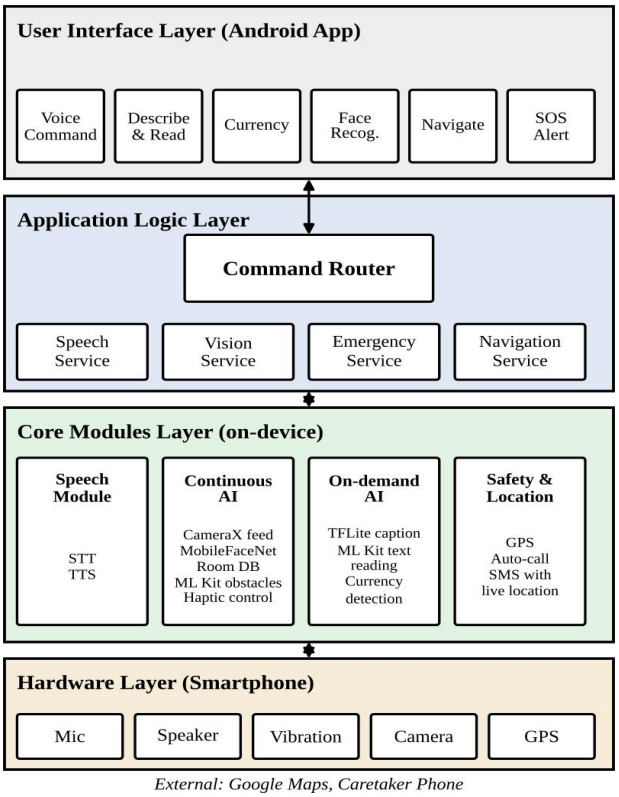


Fig. 1. Proposed four-layer system architecture of IRIS.

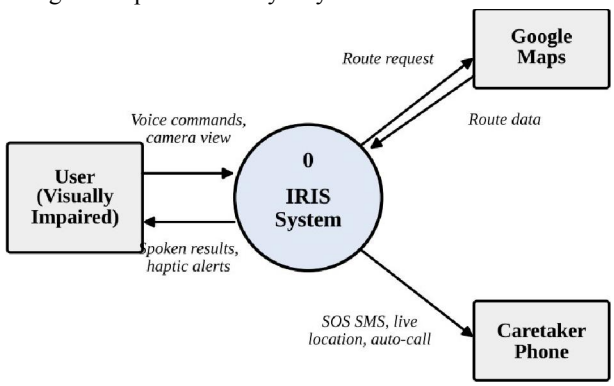


Fig. 2. Level 0 data flow diagram (context diagram) of IRIS.

lightweight, on-device AI is a promising direction for assistive tools on smartphones. The proposed system combines scene description, text reading, currency and face recognition, obstacle alerts, spoken navigation and SOS alerts in a single voice-first Android application with a four-layer architecture. By using an ordinary smartphone and on-device models, the project is highly

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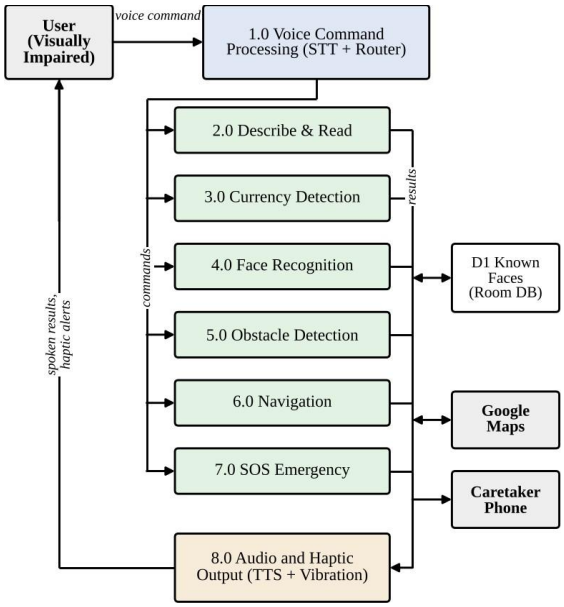


Fig. 3. Level 1 data flow diagram of IRIS.

achievable within the academic timeline; it demonstrates mo-bile application development, on-device deep learning, speech processing and location-based services; and it promotes indepen-dence, safety and inclusive digital accessibility, with the poten-tial to evolve into a smart companion for the blind community worldwide.

V. FUTURE WORK

Beyond the work planned for this project, IRIS can be extended in several directions:

- Multilingual voice support: voice commands and spoken output in regional languages.
- Larger recognition vocabulary: more object classes, cur-rency types and scene descriptions.
- Distance estimation: estimating the distance to obstacles for more precise warnings.
- Wearable integration: connecting to smart glasses or bone-conduction headphones for a more comfortable hands-free experience.
- Offline and indoor navigation: navigation without a net-work connection and inside buildings.
- Caretaker dashboard: allowing caretakers to view the live location and manage the known-faces database remotely.

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