S.A.G.E - Personalized AI-Powered Smartglass

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Contents

Introduction

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- AI-powered smartglass is designed to enhance real-world interaction through vision and voice-based features
- Built around a Raspberry Pi Zero 2 W, with a focus on software-driven functionality and minimal hardware complexity
- Integrates a custom Flutter mobile app to manage AI tasks, user controls, and real-time communication
- Features voice-triggered assistant, HUD-based feedback, facial recognition, object detection, and translation
- **S.A.G.E** : Situational Awareness and Guidance Engine. It's a situational companion designed to empower users with seamless, context-aware insights, wherever they go.

Why AI-Powered Smartglass?

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- Traditional assistive and wearable tech often lacks intelligence, real-time adaptability, and affordability.
- Our smartglass leverages AI to provide intuitive, voice-based interaction and real-time visual understanding.
- Enhances accessibility, especially for visually impaired users, by offering on-demand object and face recognition.
- Offloads complex tasks like translation and environment understanding to a companion app and hosted AI backend.
- Bridges the gap between affordability, functionality, and intelligent personal assistance in a compact form factor.

Why AI-Powered Smartglass?

- The system integrates specialized AI modules to handle distinct smartglass functionalities:
  - Voice-activated assistant for hands-free interaction,
  - Real-time object and facial recognition for environmental awareness,
  - Text translation through live camera input,
  - HUD display rendering for visual feedback.
- Enables on-demand AI features, triggered by voice, to assist users contextually and adaptively.
- SAGE redefines affordable, intelligent wearables by merging accessibility, AI capabilities, and intuitive UX in a compact form.

Features

HUD Interaction & Visual Recognition

Heads-Up Display (HUD)

- **Live Visual Feedback:** Reflects real-time information such as navigation, translation, or object labels.
- **Context-Aware Display:** Dynamically updates based on voice commands and environmental input.

Visual Recognition

- **Object Detection:** Identifies objects in the user's environment using ML models.
- **Facial Recognition:** Detects and recognizes familiar faces.

System Architecture & Module Collaboration

Modular Design

- **Distributed Responsibilities:** Divide tasks across Raspberry Pi, mobile app, and hosted backend (e.g., UI, ML inference, internet APIs).
- **Optimized Processing:** Run lightweight tasks on-device and delegate intensive operations to the app/server.

Module Collaboration

- **Voice, Vision, and Display Integration:** Modules communicate via local server hosted by Raspberry Pi.
- **Synchronized Workflow:** Seamless coordination enables real-time feedback through HUD and speaker.

Customization & Performance Assurance

User-Centric Customization

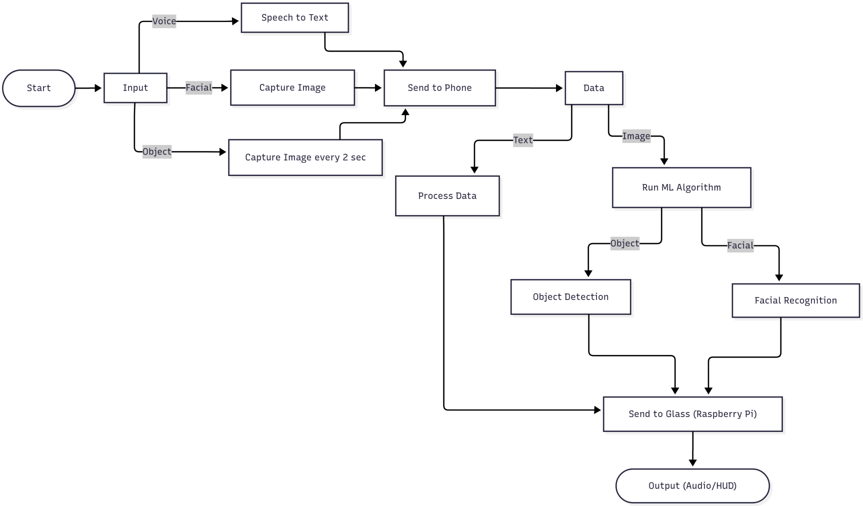
- **Context-Based Interaction:** Customize behavior based on user needs—accessibility, productivity, or travel.
- **Modular Feature Control:** Enable or disable object scanning, translation, or music control as needed.

Performance Assurance

- **Latency Optimization:** Offload AI tasks to backend while maintaining responsive HUD and voice processing.
- **Thermal Efficiency:** Offloaded ML models avoid overheating and maintains usability.

Flowchart

Flowchart



Start
Input
Voice
Speech to Text
Facial
Capture Image
Object
Capture Image every 2 sec
Send to Phone
Data
Text
Image
Process Data
Run ML Algorithm
Object
Facial
Object Detection
Facial Recognition
Send to Glass (Raspberry Pi)
Output (Audio/HUD)

Literature Survey

BASE PAPER - Smart Navigation Glasses For Independent Living[1]

Sathya, V., Preetha, H., Gopika, K.

- A smart wearable system combining ESP32-CAM, ultrasonic sensors, and Raspberry Pi for real-time obstacle detection
- Integrates OpenCV and TensorFlow Lite for machine learning-based object and facial recognition
- Modules include text-to-speech, obstacle discovery, facial recognition, and SOS messaging
- Provides both online and offline object detection with Clarifai and TensorFlow for robust performance
- Includes Bluetooth connectivity, step tracking, ambient temperature sensing, and FTP for media transfer
- Designed for accessibility, affordability, and adaptability to aid visually impaired individuals in daily navigation

Visual Information Translator Using Smart Glasses for Blind[3]

Rani, T.P., Vignesh T., Susila Sakthy S., Priyadharshan M., Kalaichelvi P.

- IoT and Machine Learning-based smart glasses system for the visually impaired
- Equipped with Pi Camera, Microcontroller, Bluetooth/WiFi module, and mobile app interface
- Modules include text-to-speech conversion, object and obstacle detection, and facial recognition
- Uses Google ML Kit and TensorFlow Lite for real-time image processing and feedback
- Features SOS alert system, health report database, and interactive voice feedback to improve autonomy and safety

Smart Glasses Embedded with Facial Recognition Technique[7]

Kumar, M., Bharti, B., Chauhan, U.

- Raspberry Pi-based smart glasses system for visually impaired, with facial recognition and obstacle detection
- Uses ESP32 camera, ultrasonic sensors, Google Text-to-Speech, and Python for real-time assistance
- Identifies known individuals and objects from a preloaded database, announcing identity and distance
- Ultrasonic sensor alerts user about unrecognized obstacles or persons, enhancing spatial awareness
- Designed to be cost-effective, lightweight, and easily extendable with additional modules for various assistive functions

Facial Recognition Smart Glasses for Visually Impaired People[6]

Ghodake, A., Sale, H., Kamble, A., Mankari, K., Lad, O., Mishra, V.

- Smart glasses system equipped with ESP32-CAM and Raspberry Pi for facial recognition and obstacle detection
- Uses OpenCV and Haar Cascade classifiers to identify known individuals and objects
- Implements text-to-speech module via Google API to convey visual information through audio
- Designed to recognize multiple faces and alert users via audio output with high accuracy and reliability
- Aims to reduce dependence on external assistance, promoting safety and independence for visually impaired users

Single-Shot Image Recognition Using Siamese Neural Networks[5]

Malhotra, A.

- Introduces a Siamese Neural Network model for one-shot image recognition tasks
- Designed to compare a query image against a reference image set and determine similarity
- Employs contrastive loss to learn embeddings that minimize distance between similar pairs and maximize between dissimilar pairs
- Suitable for applications where limited training data is available and conventional classification fails
- Demonstrated effectiveness in facial recognition, signature verification, and handwriting recognition tasks

Smart Glasses for Visually Impaired People using Machine Learning[2]

Siva Priyanka S., Aruru Sai Kumar, M V Nagabhushanam, Dasari Vennela, Pallakila Divya Tulasi

- Proposes smart glasses using object detection (YOLOv3) and text-to-speech (Google API) for assisting the visually impaired.
- Raspberry Pi 3 used as the core processor, with a Pi camera module and speaker for feedback.
- OpenCV is used for real-time object detection; Google TTS API converts detected objects into audio prompts.
- Enhances independent mobility and awareness by alerting users of surrounding objects.
- Achieved high object recognition accuracy, e.g., 99

Smart Glass for Visually Impaired Person[4]

Sabitha R., Senthil Pandi S., Rathi Devi J., Jegan G.

- IoT-enabled smart glasses integrating GPS, ultrasonic sensors, ESP32-CAM, and Bluetooth for real-time navigation and emergency support
- Provides obstacle detection with audio feedback and alerts emergency contacts with live video and location in unfamiliar environments
- Includes mobile app for managing settings, monitoring, and communication with emergency contacts
- Reduces notification fatigue by distinguishing between familiar and unfamiliar locations
- Utilizes YOLO for object recognition and GPS for geo-fencing, enhancing autonomous mobility for visually impaired users

Indoor Navigation Glasses for the Visually Impaired[8]

Pocholo James Loresco, Rence Jerome C. Cruz, Kingsley Z. Ramones, Julia Angellica D. Zafra, Karl Russell G. Ramirez

- Proposes wearable smart glasses for indoor navigation using deep learning and audio guidance for visually impaired individuals.
- Utilizes Raspberry Pi 4B, Coral Edge TPU, and RPi Camera v2 housed in 3D-printed glasses for processing and vision.
- Incorporates MobileNetV2 for room localization and MobileNet-SSD for obstacle detection (e.g., chairs).
- Voice-activated via Vosk and PyAudio; synthesizes directional cues like "go left" or "obstacle in front."
- Achieved high performance: Navigation accuracy of 98.96

Google Pi Using Raspberry Pi for Visually Impaired[4]

Katkar, G. V., Abirami, K., Posonia, A. M., Ankayarkanni, B., Ushanandini, D.

- Introduces Google Pi – a smart assistant for the visually impaired using Raspberry Pi, Google APIs, and deep learning.
- Integrates real-time voice commands, object detection (YOLOv3), and currency recognition (CNN).
- Achieves high accuracy: 92.4
- Enhances accessibility with custom voice commands, portability, and real-time feedback via audio.
- Demonstrates significant improvement over traditional voice assistants lacking object and currency identification features.

Literature Survey (1/3)

Title	Authors	Key Findings	Advantages	Disadvantages	Inferences
Smart Glasses for Visually Impaired People using Machine Learning	Siva Priyanka S, Aruru Sai Kumar, M V Nagabhushanam, Dasari Vennela, Pallakila Divya Tulasi	• Uses Raspberry Pi 3 with camera module YOLOv3 for object detection • OpenCV and Google API for TTS provide real-time obstacle detection and audio alerts.	• Real-time detection • speech guidance • low cost • OpenCV support.	• Limited detection classes may struggle in cluttered scenes.	• Boosts mobility and safety using YOLO on embedded hardware.
Visual Info Translator Glasses Using Smart Glasses for Blind	T.P. Rani, Vignesh T, S Susila ,P Kalaichelvi	• Uses OCR and text-to-speech to convert printed text into audio output for blind users via smart glasses.	• Real-time visual-to-audio conversion • portable and non-intrusive design.	• Limited to printed text • not effective for complex visual scenes or handwriting.	• Effective for reading printed material • extends accessibility to printed media for the visually impaired.
Google Pi using Raspberry Pi for Visually Impaired	Gowthami Vinod Katkar, K Abirami, A. Mary Posonia, B. Ankayarkanni, D. Ushanandini	• Introduces "Google Pi" — a smart assistant built on Raspberry Pi with Google Assistant API, YOLOv3, and CNN for real-time object. • Currency recognition to support visually impaired people. Features voice control, object identification, and financial assistance.	• Combines Google Assistant with deep learning for real-time feedback, user-friendly voice control, and portable. • Affordable hardware, and independence for visually impaired.	• Requires significant training data and computing power for CNN models. • No facial recognition or OCR included yet. • Performance may vary with lighting and background.	• Demonstrates the power of integrating Raspberry Pi with Google APIs. • Demonstrates CNN models to deliver assistive technology that enhances autonomy and accessibility for the visually impaired.

Literature Survey (2/3)

Title	Authors	Key Findings	Advantages	Disadvantages	Inferences
Smart Glass for Visually Impaired Person	Sabitha R, Senthil Pandi S, Rathi Devi J, Jegan G	• GPS, ultrasonic sensors, emergency camera, and Bluetooth-enabled mobile app • alerts sent during unfamiliar environment detection.	• Emergency alerts • recognizes safe zones • video and GPS feedback.	• Bluetooth limitations • phone dependency.	• Offers both navigation and emergency support through IoT.
Single-Shot Image Recognition Using Siamese Neural Networks	Abhiraj Malhotra	• Siamese Neural Network used for one-shot learning image recognition • high accuracy with low data.	• Few-shot learning, efficient with limited data, low memory use.	• Poor generalization on unseen classes, sensitive to noise.	• Suitable for applications with minimal samples • potential in face or object recognition.
Facial Recognition Smart Glasses for Visually Impaired People	Asha Ghodake, Hanamant Sale, Abhijeet Kamble, Krushna Mankari, Om Lad, Vinit Mishra	• Raspberry Pi based system with ultrasonic sensor and webcam • integrates Pytesseract for OCR and TTS for audio output. Facial recognition + obstacle distance estimation.	• Headphones for feedback, multiple detection supported.	• Limited face DB accuracy; audio delay possible.	• Simplifies obstacle and face recognition using Raspberry Pi.

Literature Survey (3/3)

Title	Authors	Key Findings	Advantages	Disadvantages	Inferences
Smart Glasses Embedded with Facial Recognition Technique	Mahim Kumar, Bhawana Bharti, Usha Chauhan	• Uses Raspberry Pi 4, Google TTS, ultrasonic sensors, facial recognition, and ESP32 camera • adds web browsing, music.	• Multifunctional: voice assistant + face/object detection.	• Power supply needs, bulkiness due to multiple components.	• Combines assistive and entertainment features with accessibility.
Indoor Navigation Glasses for the Visually Impaired with Deep Learning and Audio Guidance Using Google Coral Edge TPU	Pocholo J. Loresco, Rence J. C. Cruz, Kingsley Z. Ramones, Julia A. D. Zafra, Karl R. G. Ramirez	• Uses MobileNet-SSD + Google Coral Edge TPU for real-time navigation, localization, obstacle avoidance • audio cues via AUI • camera detects chairs for indoor path guidance.	• High accuracy indoor navigation, low latency, no need for external beacons.	• Only trained on specific objects (e.g., chair), requires Coral Edge TPU.	• Highly effective indoor assistive device using deep learning and audio UI.

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Thank You