

ResQ Lens: AI Powered Smart Glasses for Visually Impaired Individuals

DR. SEEMA PATIL¹, PANNAGA R BHAT², PRANAV ANANTHA RAO³, PRAJWAL P⁴, PRADEEP P T⁵

Department of CSE, B.M.S College of Engineering, Bangalore, India

I. ABSTRACT

This paper illustrates conceptualization and development of AI-Enabled Smart Glasses that utilize the edge computing capabilities of smartphones to enable visually impaired individuals to read their environment in real-time. The system combines small hardware elements such as a camera, microphone, and bone conduction speakers with a standard eyeglasses frame, while making a wireless connection to a smartphone using Wi-Fi Direct or the cellular network. At the heart of the system is a high-performance, optimized edge AI pipeline running completely on the mobile device without the need for persistent internet connectivity. Real-time processing of the video stream from the camera is realized using optimized ONNX-formatted models for each task, such as object detection (YOLOv5n), optical character recognition (OCR), and captioning the scene. Optional voice command support is also integrated and a Text-to-Speech (TTS) engine is used to provide auditory feedback using bone conduction speakers, thus allowing the user to remain cognizant of their surroundings. The project focuses on portability, low power consumption, and offline operation, which are the best features for wearable AI applications. By using modern smartphone processing the architecture overcomes usage of Raspberry Pi or Arduino, reducing hardware complexity and cost.

II. INTRODUCTION

Historically, half a billion people with some form of visual impairment experience inhibition from movement, having a level or degree of awareness about their immediate environment, or even interaction with their counterparts on any sort of basis. These are the kinds of traditional and cultural disabilities because we have been using them for centuries in the form of white canes or guide dogs. It is very difficult for such traditional means to adapt with the requirements of a modern environment in a dynamic and contextual way. In contrast, modern technologies such as AI, computer vision, and mobile computing present us with opportunities to overcome these limitations and provide real-time, intelligent assistance to the visually impaired.

This work introduces the concept and design of a smart glasses system augmented by artificial intelligence that leverages the edge computing power of smartphones to conduct real-time object detection, optical character recognition (OCR), and scene description, all as audio feedback. In contrast to most current solutions based on cloud services and high-priced hardware, this scheme is cost-effective, portable, and offline-capable. By outsourcing the processing responsibilities to a contemporary smartphone, the system minimizes cost and complexity while maintaining improved performance.

The hardware consists of lightweight modules including a camera, Bluetooth earbuds or Wired Earphones (microphone, and conduction speakers), mounted on standard eyeglass frames and connected to a smartphone via Wi-Fi Direct or mobile hotspot.

This solution is geared towards assisting users in increasing their environmental consciousness, which includes the identification of objects (vehicles, obstacles, pedestrians), reading signs and printed texts (bus numbers, shop boards), and describing natural-language surroundings. ONNX models are used to guarantee the compatibility performance of different mobile devices. Optionally, voice commands may be enabled, allowing for hands-free operation of the system. In this regard, the system architecture, the hardware-software interface, and the edge inference pipeline-related concepts are provided. Finally, we present performance metrics, user-centered design considerations, and possible enhancements toward a solid, real-time assistive device for the visually impaired.

III. RELATED WORKS

A. LITERATURE SURVEY

D. I. De Silva et al., [1] provide numerous research studies which discusses the application of AI and computer vision for augmented learning of the visually impaired. Conventional practices such as braille texts and tactile equipment usually are non-interactive, particularly in math. Modern deep models like YOLO, Faster R-CNN, and Mask R-CNN

can now accurately identify objects in real-time. Experiments have proved to be effective in detecting geometric shapes and lab equipment. High-quality image data sets and data augmentation strategies have enhanced performance. YOLO V8 has exhibited better accuracy and speed than the existing versions. The current research uses YOLO V8, Google Colab, and Flutter with Python for real-time object detection and text-to-speech feedback based on GPT 3.5. Future developments can be multilingual assistance, light wearable technology, low app reliance, and TPU support for better training time, with the goal of offering inclusive education to Sri Lankan blind students.

Siva Priyanka S. et al., [2] present the research about the smart glasses system which utilizes object detection and speech-to-text functionality on Raspberry Pi, OpenCV, and YOLO V3 algorithm. The glasses will help partially blind people by detecting obstacles and offering instant audio output through text-to-speech conversion using Google API. The camera module records image frames, and the YOLO V3 is applied for object detection. The identified object's description is transmitted to the Google API, which interprets it in an MP3 audio output format for the user. The research estimates that roughly 2.2 billion visually impaired individuals around the globe are afflicted with a degree of visual impairment, of whom most are over the age of 50. The proof of concept is a demonstration of how independent mobility and situational awareness can be augmented for people with visual impairment.

Shahira Kc. et al., [3] presents in-depth information on computer vision applications and assistive technologies developed for visually, hearing, and speech-impaired individuals. It presents comparative studies of legacy technologies and recent deep learning (DL) methodologies in object detection, navigation, and scene description. Traditional wayfinding and reading has been improved by applying DL algorithms like YOLO, SSD, and Faster R-CNN, providing more accurate and real-time scene comprehension. The article gives detailed comparison about various sensors used in object detection with each other in terms of parameters like depth understanding and precision. Navigation guidance provided by combining RGB cameras with infrared sensors provides the ability to recognize objects, which leading to some challenges such as shadow, occlusion, and change in light. The research further categorizes techniques into region proposal-based techniques and single-shot-based techniques for enhanced object detection. The paper further discusses reading modules that translate images to text for the blind and analyzes current market solutions, listing their sensors, features, and shortcomings. Apart from visual impairment, it points out technologies aiding those with hearing and speech impairments, such as assistive listening devices and alert systems. Future developments focus on sensor and algorithm optimization for quicker data processing, enhancing the reliability and availability of assistive devices.

Mohamed Dhiaeddine Messaoudi et al., [4] presents a comprehensive study of various assistive and navigation technologies for visually challenged people, explaining in short about traditional tools like white canes and guide dogs with advanced technologies like RFID, Bluetooth, and barcode technologies. The study details the advantages and limitations of each technology, depending on power consumption, cost, and accuracy. Zigbee-based, Bluetooth, Wi-Fi, GPS, and ultrasonic-based system navigation are all compared, tapping into methods such as triangulation and trilateration in determining location. Camera-based systems are also introduced in the paper as a point for comparison between the various types of environments. The feedback mechanisms, including audio announcements, vibration haptic feedback, and pulse signaling for movement awareness, are explored as well. These systems, such as the smart canes, Roshni system, and outdoor navigation using RFID tag grid systems, are compared with respect to their efficiency. Infrared and RGB-D sensor-based options have been cited, alongside systems that process visual data into speech through Google OCR and MATLAB. Existing mobile navigation applications in the market are contrasted on the basis of their features, usability, and affordability. In conclusion, the study offers a comparative analysis of algorithms, datasets, and technology constraints and suggests points of improvement to enhance ease of access for the visually impaired in indoor and outdoor environments.

Hania Tarik et al., [5] presents various insights about a smart walking cane for the Partially Impaired people with an embedded camera for obstacle detection and a speaker module for real-time auditory feedback. GPS and GSM modules are also included to send alerts in the event of an emergency. The review of literature addresses various models available, their advantages, and disadvantages in a comparative table. For detecting objects, CNN, R-CNN, and YOLO series models were experimented with by the researchers. YOLO V4 Tiny was utilized since it provided a balance of accuracy and speed, with mAP at 43.5%. Object detection processing was done for the camera input from a Raspberry Pi 3B, whereas ultrasonic sensors at various orientations sensed obstacles at close proximity. Detected objects were notified to the user through a speaker module by utilizing the Google Text-to-Speech (gTTS) library. During emergencies, the system initiated GPS location detection by GPRS and alerted family members by GSM. The COCO dataset, consisting of 328,000 images from 80 object classes, was used to pretrain the YOLO V4 model, which boasts strong performance in indoor and outdoor environments. Testing in real-world conditions showed successful detection of obstacles and positive voice feedback, helping users get around their environment. Nonetheless, issues like sensing small objects on the floor and short battery life were reported. The prototype cost was approximated at Rs 21320. Improving object detection during night-time, RFID incor-

poration for indoor navigation enhancement, and optical character recognition (OCR) to read study materials are future upgrades to enable more independence among visually impaired users.

Rakesh Chandra Joshi et al., [6] introduce a machine learning-based innovative wearable assistive device, an artificial intelligence (AI) - SenseVision, to process visual and sensory data regarding the objects and obstacles available in the environment in order to sense the surrounding world. The device is a total integration of sensor and computer-vision-based technologies to produce auditory data with the name of recognized objects or sound warnings for recognized obstacles. The performance of the trained deep-learning model is extensively tested under challenging and real-world situations employing different statistical measures for experimental validation. In addition, the trained deep-learning models have been ported into a low-cost single-board processor to create a stand-alone cost-effective device. The entire processing of data is performed in an optimized single hardware platform, and the user has easy access to various modes, including indoor mode and outdoor mode, as well as facilitating object counting in viewed scenes. The final prototype of the proposed device is a compact, portable, and standalone device, having multiple functionalities to help VIPs access for different purposes. Future work includes more functionalities and more sensors to make a more efficient standalone device for performing different obstacle detection and avoiding any kind of hurdle while navigating around, as per the feedback from the VIP.

Yi-Ler Poy et al., [7] aim at the conception of a smart glass system carefully crafted to meet the specific requirements of the blind and visually impaired (BVI) population. Unlike current solutions, the smart glass suggested here is an independent device, which does not require a constant internet connection or dependency on other devices like smartphones or an external processor for computation. The system includes three primary modules: object recognition, text face and face recognition using YOLOV8, KerasOCR and FaceNet, respectively. The hardware comprises Raspberry Pi Zero 2 W and Intel Neural Compute Stick 2, making efficient deployment of edge-based deep learning model. The YOLOV8 model is trained both on ImageNet and a custom Malaysian currency dataset containing 270 object classes. Offline speech recognition using Vosk-API is used to improve user interaction, offering input and output via a built-in speaker and MEMS microphone. The system is comprised of three main modules: object recognition, face recognition and text recognition. Because the system needs to be portable and lightweight, the Raspberry Pi Zero 2 W is used as the processor, and the computationally costly deep learning models are run on the Intel Neural Compute Stick 2. The system can operate completely offline by eliminating the requirement for internet connectivity or other equipment to offer more computing capability. The result indicates that

the system works well in detecting objects, faces and texts.

Amit Sing Mehta et al., [8] created vision-assist spectacles that utilize the Internet of Things (IOT) to help blind individuals read and interpret English-typed text and inform them of relative information through an earphone as feedback. It also helps the user tackle everyday issues by sensing and detecting approaching objects and warning the user through the use of an earphone. The device is capable of recording and processing the visual data that can be observed by normal-sighted humans and assists visually impaired individuals to better comprehend their world at a lower cost. Voice recognition in the device is based on the services of a processor. An exclusive voice recognition application that interacts with the device through Bluetooth needs to be installed on the smartphone. The software will have two options that will be Text to Speech mode and Vision to Speech mode. The future work of the paper includes the integration of AI Assistants and improved object recognition on the vision assist glasses.

Chen Zhou et al., [9] present GlassMail, a Large Language Models (LLMs)-based wearable assistant on Optical See-through Head-Mounted Displays (OHMDs) for mobile email composition. Their exploratory study revealed two challenges of the LLM-based wearable email assistant: efficient and accurate comprehension of user intent, and effective information presentation for email procedures. In two empirical experiments, they constructed a "Single Turn with Optional Clarification" paradigm for correct recognition of user intent and a "Fade Context with Optional Audio" mode for proper email processing. An observation study subsequently tested the feasibility of GlassMail in the writing of formal and semi-formal emails for supporting the helpfulness and usefulness of GlassMail in easy tasks and for making suggestions regarding how to make things better for challenging tasks. They also elaborate on the design implications for the future of wearable AI-powered assistants.

Ramani Bai Velayudhan et al., [10] introduce a holistic AI-based system that is developed to promote accessibility and empowerment for the visually impaired. The system resolves crucial challenges in this segment, such as self-grooming and environmental awareness. The main component of this system is dress description, an essential element of self-grooming. Taking advantage of the capabilities of Large Language Models like the Visual Question Answering (VQA) model, their system offers live dress descriptions, allowing users to make independent decisions regarding their wardrobe. This aspect greatly enhances users' confidence and independence in everyday dressing practices. Their system also includes sophisticated AI features to complement user experience. Face recognition, driven by DeepFace technology, allows smooth recognition of people, making social interactions and safety easier. Object finder system, developed on the basis of YOLOv5, helps users find and identify objects within their environment, increasing their spatial awareness.

Additionally, the scene description system, implemented on the basis of Vision Transformer (ViT) models, informs users about a detailed description of their surroundings, increasing their awareness of their environment. By combining these innovative AI technologies, their system not only solves the present problems of the visually impaired but also enables them to interact more independently and confidently with the world. This paper describes the design, development, and potential contribution of the AI-based system to show why it is important for enhancing the quality of life of visually impaired individuals.

Nirav Satani et al., [11] introduce a device that employs AI-powered smart glasses to aid the navigation of visually impaired users. The device consists of a Raspberry Pi computer, camera, headphone, and power supply needed to send captured images to the Raspberry Pi for immediate extraction of information with deep learning (R-CNN) to display the analysis, or, output, as an audio file to the user via a headphone (i.e., the user would be notified of who is standing in front of them). The device also integrates OCR with the use of the Tesseract library for reading text. The paper reviews the existing technologies available to assist disabled people and the methods used by the device, analyzes its performance, and discuss these alternatives to the device and its performance, while drawing context concerning future endeavors and applications, based on its promising results, even while noting specific limitations around processing speed and possibility, due to the aforementioned speed, to extract particular objects.

BDB Kumar et al., [12] introduce such a smart reader using Raspberry Pi technology that will help blindfolded people in reading. Braille has been a good aid, but it has few trained users and resources for it; thus, the system proposes a combination of YOLO with OCR and Google Text-to-Speech for converting printed text into spoken words. This complete integration of all the sensors and cameras with AI deep learning algorithms shall further help in making smart glasses to read in real-time, whether during work or at home, and ease out all daily tasks for vision-impaired users.

A. N. Nithyaa et al., [13] highlight the barriers that visually impaired individuals continue to face in reading printed text, recognizing objects, and identifying familiar faces. Existing assistive technologies in the form of voice-over speakers or finger readers do provide a some help but by far require manual inputs, thus limiting their efficacy. Therefore, the authors have proposed AI-powered smart glasses, which use state-of-the-art computer vision and machine learning techniques. Equipped with a camera, these glasses capture and process text, objects, and faces, transforming them into speech through earphones or speakers. In fact, by analyzing the environment continuously, the system can provide the end user with real actual-time feedback for decent mobility and independence. Moreover, with augmented reality

technology, the performance of augmented reality-capture strategy enables further improvement of navigation and human-computer interaction that seals the gap between visual limitations and real-world challenges.

Mukhriddin Mukhiddinov et al., [14] propose smart glass systems that use deep learning algorithms to help the blind as well as the visually impaired users navigate their environment and augment their experiences, more especially under low-light conditions. The program will be integrated into the system using ways found in computer vision and AI techniques to improve awareness about the surrounding with four important components, like low-light image enhancement, object recognition using audio feedback, salient-object detection, and text-to-speech with tactile graphics. A two-branch exposure-fusion network through transformer-based object detection will build the real-time functionality to enable users to recognize objects, read text, and navigate independently. Results on very challenging datasets such as Low-Light and ExDark show that the tool is an effective assistant in overcoming mobility and accessibility obstacles for visually impaired individuals.

Bhanuka Gamage et al., [15] investigate the increasing influential role that AI-smart assistive devices play in serving people having high degree vision impairment find their way around location. Although smart glasses have now drawn a lot of publicity for technological advancement and for their natural positioning, little research focuses on users' preferences. The study intends to fill this gap by applying a Design Thinking approach involving vision-impaired users in co-designing methods. Through prototyping and usability testing of prototypes of smart glasses with blind, visually impaired, or CVI individuals, the study wishes to understand user preferences and improve accessibility. The end state will be software architecture providing seamless access to environmental information improving everyday lives for visually impaired individuals.

J. Bai et al., [16] presented an assistive device that integrates wearable technology and artificial intelligence for improving navigation and environmental perception in visually impaired people. The system employs computer vision and sensors to achieve motion tracking and depth perception. The image is captured by an RGB-D camera, while motion data is captured by an inertial measurement unit (IMU). Visual information in real time is converted into useful information by employing a low-power convolutional neural network to detect and classify obstacles. The device includes a revolutionary algorithm for ground surface separation to determine safe and walkable routes, both indoors and outdoors, for efficient movement. It includes an auditory human-machine interface (HMI) with the interactions including verbal guidance of navigation, object recognition, and alerting for obstacles. The whole system runs from a smartphone computer device, and the system has real-time

processing at around 20 frames per second, with portability and affordability. The device has been tested in several validation tests in real environments and showed superior improvements over typical mobility aids like white canes. Additional research will focus on improving detection of obstacles with the ability to return tactile feedback in addition to navigating stairs, improving utility and ease of use over a wider setting.

Varshney et al., [17] outline an AI-based wearable device in the form of Smart Vision Glasses (SVG) to aid visually challenged persons in navigation, object detection, and reading assistance. Computer vision, deep learning, and LiDAR depth estimation enable the application of object detection by Convolutional Neural Networks (CNNs) coupled with Optical Character Recognition (OCR) algorithms for text recognition from different materials like books, papers, and currency. The $f(n)=g(n)+h$ form of the A* search algorithm is used to determine the optimal walking path in real-time dynamically in a real-time updated manner in order to avoid obstacles and improve mobility. Facial recognition, showing an accuracy rate of 88.5% and a satisfaction rate of 65.4% in reading assistance, is still struggling with serious limitations in mobility assistance, with obstacle detection showing more than 15% error in dense environments and currency recognition less than 70% accuracy, thus hindering its application in financial transactions. The specified constraints indicate the need for the development of real-time processing technology, sophisticated tactile feedback systems, and artificial intelligence-based recognition systems. The future technologies need to be designed to minimize false-positive detection of obstacles, require peak computational resources, and provide maximum flexibility in a broad range of application environments to facilitate effortless and effective implementation, as well as cost-effectiveness for widespread adoption.

I Jeong et al., [18] 's research presents a mobility aid system on YOLOv8 XR smart glasses. Deep learning, computer vision, and extended reality (XR) technologies will enhance outdoor navigation for the visually impaired. The semantic segmentation model segments the user's field of view into nine risk regions and uses a weighted function to account and prioritize risk by distance, location, and maneuvers. The safe walkway navigation system mathematically defined as identifies pedestrian-friendly paths adaptively guiding the decision on navigation cues. The system runs on Xreal Light smart glasses, with an Android smartphone, with measured processing of 60 FPS with an average latency of 583 ms and an 80 MB memory footprint for real-time occurrence feedback. YOLOv8n is trained with a dataset of 11,071 images for walkway detection, 7,144 images for transporting facility detection; and 296,949 images for detecting obstacles, with an F1 score of 0.842 in road detection and 0.698 in crosswalk recognition. However, limited generalization of the dataset to different urban structures and performance degradation in low-light conditions are not without complexity. There

are also battery life constraints (operation for 2 hours in a smartphone-driven mode), and energy optimization would be beneficial in future designs. In addition, the inclusion of real-time public transport information and improved nighttime detection will enable more inclusive and usability of the assistive device for independent mobility of visually impaired individuals.

Yildirim, I et al., [19] 's study presents smart glasses for vision assistance for visually impaired persons. These glasses have building blocks, such as a Raspberry Pi 4 as a microprocessor, a high-definition camera, touch controls, and integrated headphones. The methodology includes image capture and the processing of these images through convolutional neural networks (CNNs) for object recognition, text reading (OCR), and face recognition, which helps in providing real-time auditory feedback through a visual question-answering (VQA) model. The hardware includes a 5MP camera with a 70° field of view, LiPo battery, cooling fans, and integrated speakers, while the software part runs deep learning models for object detection, NLP for query-based interaction, and local encrypted data processing to ensure privacy. The glasses use a simple-design push button for image capture and feature a touch interface for control; audio feedback can be customized to the individual user. Although the system's 78% accuracy rate in comparing two results somewhat confirms GPT-4's 82%, the system is touted for increasing user independence; power consumption, battery life, and response time optimization are still considered significant challenges. Possible future work will focus on energy efficiency, cloud integration for AI, and increased training datasets for improved accuracy.

N Nasser et al., [20] 's article discusses how mobility aid for the blind can be created based on the real-time navigation aid created using digitized mobile apps developed on AI and IoT technology. The method combines GPS, speech recognition on AI, routing optimization on ML, and IoT sensors to offer real-time updates for schedule changes, rerouting, and roadblocks. It processes locally or in the cloud to offer travel recommendations using a text to speech output or audio alert. The article critically analyzes current mobile apps like TransmiGuia, TEUBICAIS, and NavTU, citing some of the limitations to include the absence of real-time updates, complex transit systems, and inaccessible obstacles. Suggested solutions are voice navigation based on AI, smart wearables, and an IoT-based signal-controlled system to enhance independence. Other issues revealed by the research are cost, privacy concerns, and unavailability of more flexible AI models. Future studies, however, would investigate issues like enhanced accuracy with AI, integration into transport systems at no additional cost, and smart mobility solutions for the blind being affordable and available. All these will need to be supported by researchers, policymakers, and technology developers in a collaborative effort to create the best and most inclusive available assistive technology.

No.	Model	Accuracy	Comparison with Ours
1	YOLOv8	~85%	YOLOv5 is faster and more accurate; lacks OCR & ONNX-lite
2	YOLOv3	75-99%	YOLOv5 improves detection; ours adds OCR and ONNX-lite for edge support
4	YOLOv4-tiny + Google TTS	43.55% mAP	Less accurate than YOLOv5; lacks OCR; ONNX-lite makes ours lighter
5	Custom CNN	~82%	Slower and lacks real-time features and OCR/ONNX-lite
6	Faster R-CNN + CRNN OCR	80% detect, 75% OCR	Slower than YOLOv5; OCR less accurate; lacks ONNX-lite
7	SSD + EAST	78% detect, 70% OCR	Less accurate; EAST is slower than YOLOv5 + ONNX-lite
8	YOLOv5 (vanilla)	~90%	Similar accuracy; our model includes OCR & ONNX-lite
9	RetinaNet + Tesseract	82% detect, 65% OCR	Slower and less accurate OCR; no ONNX-lite
10	EfficientDet + CRNN	~85%	Comparable, but heavier; ours enables edge use with ONNX-lite

TABLE 1: Comparison of Our Model with Existing Approaches

B. METHODOLOGY

As shown in Fig. 1; The smart glasses design integrates several technologies by which a smartphone is used as an edge processing device.

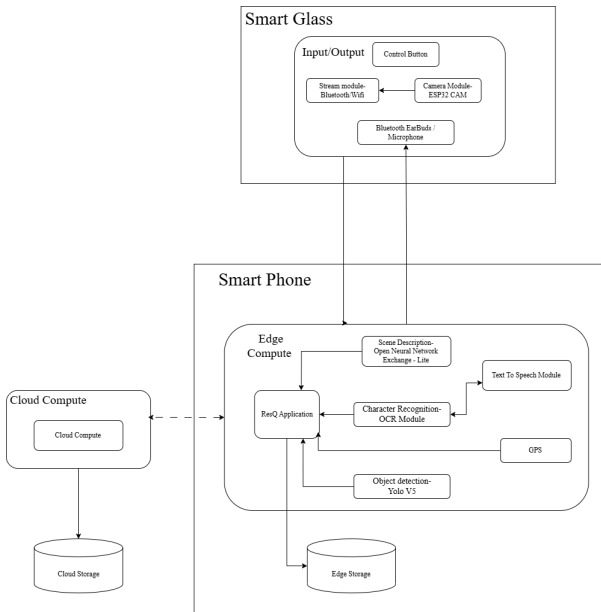


FIGURE 1: Application Architecture

The processing device of the smart glasses has several input components such as an ESP32-CAM module for capturing video and a control button for user inputs and Bluetooth earbuds and wired earphones for microphone and speaker purposes. The smartphone is interfaced with these hardware units via Bluetooth or OTG technology. Smartphone apps which operate video stream processing using dedicated AI models YOLOv5n for object detection and Tesseract or ML Kit for optical character recognition. A scene description module specially designed using ONNX-lite generates summaries which are translated into spoken words by the Text to Speech engine. The earbuds provide the output audio to users for a seamless interactive experience. The Cloud Module acts as a backup system that is triggered after the Edge Computing Module exceeds its set timeout period or incurs delays in

executing complex operations within tolerable latency so that the system still provides proper response time. The system allows users to reach out to their relatives during emergency cases. The built-in voice recognition capabilities in the mobile operating system make voice commands possible. Low latency, efficient energy use, and real-time situational awareness offered by the scalable and modular structure make it suitable for assistive applications.

REFERENCES

[1] D. De Silva, S. Vidhanaarachchi, R. Ranasinghe, M. Jayasooriya, D. Jayawardhana, and D. Savishka, "Enhancing learning experiences for visually impaired students with ai and machine learning on smart device," in 2024 International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA). IEEE, 2024, pp. 1–6. [Online]. Available: <https://ieeexplore.ieee.org/abstract/document/10550610>

[2] A. S. Kumar, M. Nagabhushanam, D. Vennela, P. D. Tulasi et al., "Smart glasses for visually impaired people using machine learning," in 2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT). IEEE, 2023, pp. 1–6. [Online]. Available: <https://ieeexplore.ieee.org/abstract/document/10307374>

[3] K. Shahira, C. Sruthi, and A. Lijiya, "Assistive technologies for visual, hearing, and speech impairments: Machine learning and deep learning solutions," Fundamentals and Methods of Machine and Deep Learning: Algorithms, Tools and Applications, pp. 397–423, 2022. [Online]. Available: <https://onlinelibrary.wiley.com/doi/abs/10.1002/9781119821908.ch17>

[4] M. D. Messaoudi, B.-A. J. Menelas, and H. Mcheick, "Review of navigation assistive tools and technologies for the visually impaired," Sensors, vol. 22, no. 20, p. 7888, 2022. [Online]. Available: <https://www.mdpi.com/1424-8220/22/20/7888>

[5] H. Tarik, S. Hassan, R. A. Naqvi, S. Rubab, U. Tariq, M. Hamdi, H. Elmannai, Y. J. Kim, and J.-H. Cha, "Empowering and conquering infirmity of visually impaired using ai-technology equipped with object detection and real-time voice feedback system in healthcare application," CAAI Transactions on Intelligence Technology, 2023. [Online]. Available: <https://ietresearch.onlinelibrary.wiley.com/doi/full/10.1049/cit2.12243>

[6] R. C. Joshi, N. Singh, A. K. Sharma, R. Burget, and M. K. Dutta, "Ai-sensevision: a low-cost artificial-intelligence-based robust and real-time assistance for visually impaired people," IEEE Transactions on Human-Machine Systems, 2024. [Online]. Available: <https://ieeexplore.ieee.org/abstract/document/10485529>

[7] Y.-L. Poy, S. Darmaraju, C.-H. Goh, and B.-H. Kwan, "Standalone smart glass system for the blind and visually impaired," in 2024 IEEE 14th Symposium on Computer Applications & Industrial Electronics (ISCAIE). IEEE, 2024, pp. 239–244. [Online]. Available: <https://ieeexplore.ieee.org/abstract/document/10576410>

[8] A. S. Mehta, A. Singh, A. K. Sagar et al., "Vision assist glasses for visually impaired people," in 2024 2nd International Conference on Networking and Communications (ICNWC). IEEE, 2024, pp. 1–8. [Online]. Available: <https://ieeexplore.ieee.org/abstract/document/10537459>

[9] C. Zhou, Z. Yan, A. Ram, Y. Gu, Y. Xiang, C. Liu, Y. Huang, W. T. Ooi, and S. Zhao, "Glassmail: Towards personalised wearable assistant for on-the-go email creation on smart glasses," in Proceedings of the 2024 ACM Designing Interactive Systems Conference, 2024, pp. 372–390. [Online]. Available: <https://dl.acm.org/doi/abs/10.1145/3643834.3660683>

[10] R. B. Velayudhan, J. C. Baby, A. Deepan, J. Tony, and A. T. Baiju, "Self grooming and personal assistance for visually challenged using llms and deep learning models," in AIP Conference Proceedings, vol. 3280, no. 1. AIP Publishing, 2025. [Online]. Available: <https://pubs.aip.org/aip/acp/article-abstract/3280/1/020010/3334385>

[11] N. Satani, S. Patel, and S. Patel, "Ai powered glasses for visually impaired person," International Journal of Recent Technology and Engineering (IJRTE), vol. 9, no. 2, pp. 416–421, 2020. [Online]. Available: https://www.researchgate.net/publication/363669002_AI_Powered_Glasses_for_Visually_Impaired_Person

[12] B. D. B. Kumar, B. U. Sai, S. S. Karthik et al., "Ai-integrated smart glasses for enhancing reading and guidance independence for the

- visually impaired,” *Journal of Trends in Computer Science and Smart Technology*, vol. 6, no. 3, pp. 235–247, 2024. [Online]. Available: <https://irojournals.com/tcsst/article/view/6/3/2>
- [13] A. Nithyaa, R. Premkumar, N. Sudhandirapriya, and R. Durga, “Eye glasses for the visually challenged using artificial intelligence application,” in *International Conference on Soft Computing and Signal Processing*. Springer, 2023, pp. 347–360. [Online]. Available: https://link.springer.com/chapter/10.1007/978-981-99-8628-6_30
- [14] M. Mukhiddinov and J. Cho, “Smart glass system using deep learning for the blind and visually impaired,” *Electronics*, vol. 10, no. 22, p. 2756, 2021. [Online]. Available: <https://www.mdpi.com/2079-9292/10/22/2756>
- [15] B. Gamage, “Ai-enabled smart glasses for people with severe vision impairments,” *ACM SIGACCESS Accessibility and Computing*, no. 137, pp. 1–1, 2024. [Online]. Available: <https://dl.acm.org/doi/abs/10.1145/3654768.3654771>
- [16] J. Bai, Z. Liu, Y. Lin, Y. Li, S. Lian, and D. Liu, “Wearable travel aid for environment perception and navigation of visually impaired people,” *Electronics*, vol. 8, no. 6, p. 697, 2019. [Online]. Available: <https://www.mdpi.com/2079-9292/8/6/697>
- [17] A. S. Varshney, M. E. Chougale, C. V. Patel, and M. D. Chauhan, “Evaluating usability of “the smart vision glasses” for individuals who are visually impaired and totally blind,” *Saudi Journal of Ophthalmology*, pp. 10–4103, 2025. [Online]. Available: https://journals.lww.com/sjop/fulltext/9900/evaluating_usability_of_the_smart_vision_glasses_78.aspx
- [18] I. Jeong, K. Kim, J. Jung, and J. Cho, “Yolov8-based xr smart glasses mobility assistive system for aiding outdoor walking of visually impaired individuals in south korea,” *Electronics*, vol. 14, no. 3, p. 425, 2025. [Online]. Available: <https://www.mdpi.com/2079-9292/14/3/425>
- [19] I. Yıldırım, I. Demir, I. Peker, M. E. Yılmaz, O. Güneşli, E. S., Aktas, E. Özer, and E. Kantaroglu, “Vision assistant for visually impaired individuals,” *Journal of Computer & Electrical and Electronics Engineering Sciences*, vol. 2, no. 2, pp. 62–66, 2024. [Online]. Available: https://www.researchgate.net/profile/Emrah-Kantaroglu-2/publication/385498982_Vision_assistant_for_visually_impaired_individuals
- [20] N. Nasser, A. Y. Ali, L. Karim, and A. Al-Helali, “Enhancing mobility for the visually impaired with ai and iot-enabled mobile applications,” *ScienceOpen preprints*, 2024. [Online]. Available: <https://www.scienceopen.com/hosted-document?doi=10.14293/PR2199.000775.v2> ***