

AIoT Smart Specs: An Assistive Technology for the Visually Impaired - A Review

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Abstract: Visually impaired human beings face many demanding situations of their day by day lives. As conscientious members of society, it is our solemn duty to assist them in leading lives akin to ours, harnessing the potential of cutting-edge technologies such as AI-driven Computer Vision. To address this, we present an ingenious solution: AIoT-powered smart specs. These remarkable spectacles are designed to illuminate the lives of the visually impaired by harnessing their heightened perceptual capabilities to gather information from their surroundings. This Artificial Intelligence of Things (AIoT)-enabled smart specs possesses the remarkable ability to perform real-time currency recognition, character detection, object identification etc. The smart glass includes integrated cameras and sensors to capture text, images, and frames. The result is generated in vocal form, leveraging the sophisticated operations of Convolution and Recurrent Neural Networks.

Keywords: AIoT-powered smart spec, Character detection, Object detection, Real-time currency recognition, Sensors

I. INTRODUCTION

Visually Impaired people has a lot of difficulties in their daily lives. There is a say that, Out of all the five sense organs, eyes are most important. 80% of what we perceive comes from our sense of sight. According to World Health Organization (WHO), nearly 2.2 billion individuals have a close or faraway vision impairment. Yet the growth of the population is making a substantial improvement in the number of people affected. Scaling up vision impairment prevention programs at all levels is crucial due to notable inter-regional and gender disparities. The visually impaired people need the help of either a stick or a person. Vision impairment significantly influences the best of lifestyles many of the person population. Social isolation, difficulty in walking, a higher risk of falls and fractures, and premature admission to a nursing or home care are result due to vision impairment in people. The global struggle of individuals with visual impairment underscores the numerous daily challenges they encounter. To aid them in leading lives akin to ours, we introduce an innovative solution AIoT Smart Specs harnessing

cutting-edge AI-driven Computer Vision technology.

AIoT stands for Artificial Intelligence of Things. It is the convergence of artificial intelligence (AI) and the Internet of Things (IoT). AIoT refers to the use of AI technologies to process and analyze data generated by IoT devices. This integration enhances the capabilities of IoT systems by enabling them to make intelligent decisions, automate tasks, and provide valuable insights. AIoT Smart Specs are ingeniously designed to empower the visually impaired, leveraging their heightened perceptual capabilities to provide real-time currency recognition, character detection, object identification, and more. The integrated camera and sensors within these smart glasses facilitate the capture of text, images, and frames. The culmination of these technologies results in the production of vocalized feedback, enabling users to receive information in an auditory format. This auditory output enhances the user experience by providing real-time guidance and assistance, thus promoting greater independence and autonomy for individuals with visual impairments.

Overall AIoT Smart Specs, leveraging cutting-edge AI-driven Computer Vision technology, represents a significant step forward in addressing these challenges. By harnessing the power of AI and IoT, these smart glasses provide real-time assistance with tasks like currency recognition and object identification, enhancing accessibility and promoting independence for the visually impaired. Ultimately, AIoT Smart Specs offer a transformative solution to improve the lives of individuals with visual impairments, mitigating social isolation and facilitating greater inclusion in daily activities.

II. PROBLEM STATEMENT

Education is a fundamental right for all, transcending age, caste, creed, religion, or region, as it imparts knowledge, values, skills, and moral habits crucial for life. However, millions of individuals, particularly those with visual impairments or declining eyesight due to aging, encounter significant challenges in reading compared to their sighted counterparts. The growing prevalence of vision difficulties has spurred the development of a prototype aimed at alleviating these obstacles.

This innovative prototype seeks to provide a solution that enables individuals with visual impairments to read more easily and affordably. By leveraging advancements in assistive technology, the prototype addresses the specific challenges faced by those with visual impairments, ensuring greater accessibility to educational materials and other written content. This empowers individuals with visual impairments to access educational resources with greater ease, the prototype aims to promote lifelong learning and enhance educational opportunities for all. This Smart Specs helps the blind people in which that:

- Reads out the currency aloud.
- Helps to detect an object that is in front of the blind people.
- Helps to read books pages and also text written on board aloud.

III. LITERATURE SURVEY

Most of the works are implemented with the help of Camera to capture an image or video, pre-process, and detect the objects with the help of machine or deep learning algorithms.

D. M. Suraj *et al.* [1], introduced a system designed with Arduino aimed at aiding individuals with visual impairments. The system utilizes an ultrasonic sensor to detect objects positioned in front of the user. Upon detecting obstacles, the system generates an output in the form of a buzzer sound, alerting the visually impaired individual to potential obstacles in their path. This innovative approach enhances the user's spatial awareness and assists in navigating their surroundings safely. The integration of Arduino technology showcases the potential for cost-effective and accessible solutions to address challenges faced by individuals with visual impairments.

Ravi *et al.* [2], introduced a device developed with Raspberry Pi to provide assistance for individuals with visual impairments. This innovative system employs optical character recognition (OCR) technology to scan printed text, subsequently processing it through the OCR software. Following this, a text-to-speech engine is utilized to convert and amplify the recognized text into audible output. The integration of Raspberry Pi showcases the device's

capability to process and interpret visual information, thereby enhancing accessibility for those with visual impairments. Overall, this device presents a practical solution for transforming printed text into a format that can be easily understood and accessed by individuals facing visual challenges.

Larisa Dunai *et al.* [3], introduced a system intended to augment conventional aids such as white canes and guide dogs for individuals with visual impairments. The system employs stereo cameras and a portable computer to identify both static and moving objects in the user's environment. These detected objects are then translated into acoustical signals, providing users with real-time auditory feedback. Utilizing headphones, individuals can perceive this information, facilitating safe navigation within a range of 5 to 15 meters across diverse environments. This innovative approach expands the repertoire of tools available for the visually impaired, offering a comprehensive and technologically advanced solution for enhanced mobility and spatial awareness.

Ricardo Chinchá *et al.* [4], introduced a system aimed at assisting visually impaired individuals in identifying and locating objects. The system capitalizes on SURF (Speeded-Up Robust Features), a robust feature detection algorithm, for efficient and accurate object identification. The utilization of SURF features allows the system to rapidly recognize objects, providing a valuable tool to enhance the independence and navigation of blind individuals. By leveraging advanced object detection techniques, this system offers an innovative approach to empower visually impaired individuals in their daily activities. The incorporation of SURF technology underscores the commitment to leveraging cutting-edge solutions for improving accessibility and autonomy for those with visual impairments.

Cheng-Lung Lee *et al.* [5], researchers created a device like a car parking sensor to help visually impaired people. They asked 20 participants to test it alongside a white cane. Some used only the cane, some only the device, and some used both. After testing, the participants who has used both cane and device helped their mobility. It helped them move faster and avoid obstacles better. So, using the device

along with the white cane is the best way for visually impaired people to stay safe and move around more easily.

Mounir Bousbia Salah *et al.* [6], proposed a system that focuses on creating a portable navigation aid for the blind, using a microcontroller with synthetic speech output. The device provides information about urban walking routes, helping users make decisions. Additionally, it incorporates an obstacle detection system using ultrasound and vibrators, which informs the user about the location of the nearest obstacle through vibro-tactile feedback, aiding navigation for visually impaired individuals.

Dimitrios Dakopoulos *et al.* [7], proposed a portable or wearable obstacle detection system designed for visually impaired individuals, comparing them based on features and performance. It categorizes these systems and provides qualitative-quantitative measures, offering a ranking for reference without criticism. This paper also aims to inform researchers and users about the progress in assistive technology.

P. Selvi Rajendran *et al.* [8], have devised a smart glass system tailored for visually impaired individuals, integrating sensors to detect obstacles and furnish comprehensive information about their surroundings. This innovative system goes beyond obstacle detection, providing users with features such as route guidance and location-based voice instructions. By incorporating these functionalities, the smart glass aims to enhance the navigation capabilities of visually impaired individuals, offering them real-time information about their environment. The inclusion of sensors allows for precise obstacle detection, contributing to a more secure and informed mobility experience for users. Overall, this smart glass system represents a significant stride in leveraging technology to empower individuals with visual impairments in navigating the world more independently.

L. Dunai *et al.* [9], have introduced an Electronic Travel Aid (ETA) known as the 'Acoustic Prototype,' designed specifically for visually impaired users. This innovative system incorporates 3D CMOS image sensors embedded in glasses, and the image data is processed by an FPGA (Field-Programmable

Gate Array) to detect objects in the environment. To facilitate real-time navigation, users interpret information about detected objects through acoustic sounds, akin to the echolocation mechanism employed by bats. The integration of advanced sensor technology and FPGA processing ensures efficient and accurate object detection, contributing to enhanced spatial awareness for visually impaired individuals. The ‘Acoustic Prototype’ represents a significant step forward in utilizing cutting-edge technology to create assistive devices tailored to the unique needs of the visually impaired community.

Daniel Thalmann *et al.* [10], introduced a system designed to assist visually impaired individuals by

utilizing multi-sonar technology to detect nearby obstacles. This innovative approach enhances mobility and spatial awareness by providing real-time information about the surroundings. The system translates the detected obstacles into vibrotactile feedback, offering a tactile and intuitive way for users to perceive their environment. By leveraging multi-sonar technology, the system ensures accurate and reliable obstacle detection, contributing to a safer navigation experience for visually impaired individuals. Overall, this system represents a promising advancement in assistive technology, addressing the unique needs of the visually impaired community and promoting increased independence in daily activities.

IV. COMPARISON TABLE

Paper	Technology Used	Object Detection Method	Features	User Feedback
D. M. Suraj <i>et al.</i> [1]	Arduino, Ultrasonic Sensor	Ultrasonic sensor	Audible indication using buzzer sound	Not specified
A. Ravi <i>et al.</i> [2]	Raspberry Pi, Webcam, OCR	OCR, Text-to-speech	Text recognition and vocal output	Positive feedback from users
Larisa Dunai [3]	Stereo Cameras, Portable Computer	Stereo cameras	Acoustical signals translating objects into sound	Safe navigation within 5m to 15m range
Ricardo Chinchá <i>et al.</i> [4]	SURF Features	SURF (Speeded-Up Robust Features)	Efficient and accurate object detection	Enhances independence and navigation
Cheng-Lung Lee <i>et al.</i> [5]	Device similar to car parking sensor	Ultrasonic sensor	Improved mobility when combined with white cane	Faster movement and better obstacle avoidance
Mounir Bousbia Salah <i>et al.</i> [6]	Microcontroller, Synthetic Speech Output	Ultrasound, Vibrators	Urban walking route information, obstacle detection	Vibro-tactile feedback for obstacle location
Dimitrios Dakopoulos <i>et al.</i> [7]	Portable/Wearable Systems	Sensors for obstacle detection	Comparative analysis of obstacle detection systems	Provides ranking for reference
P. Selvi Rajendran <i>et al.</i> [8]	Smart Glass System, Sensors	Sensors for obstacle detection	Route guidance, obstacle detection, location-based instructions	Detailed environment information

Paper	Technology Used	Object Detection Method	Features	User Feedback
L. Dunai <i>et al.</i> [9]	3D CMOS Image Sensors, FPGA	3D CMOS image sensors	Object detection through acoustic sounds	Real-time navigation through echolocation
Daniel Thalmann <i>et al.</i> [10]	Multi-Sonar Technology	Multi-Sonar technology	Obstacle detection and vibrotactile feedback	Enhanced mobility and spatial awareness
Proposed Paper	AIoT-enabled Smart Specs	OCR, Text-to-speech	Real-time currency recognition, character detection, object identification	Not Specified

V. CONCLUSION

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In conclusion, the AIoT-powered smart specs represent a transformative leap in leveraging cutting-edge technology to enhance the lives of the visually impaired. By seamlessly integrating AI-driven Computer Vision, these innovative spectacles empower individuals with heightened perceptual capabilities, enabling real-time currency recognition, character detection, and object identification. The incorporation of Convolution and Recurrent Neural Networks, coupled with sensors and cameras, facilitates comprehensive environmental awareness. This ingenious solution serves as a beacon of inclusivity, fostering independence and accessibility for the visually impaired in navigating their surroundings.

As conscientious contributors to societal progress, it is our responsibility to champion such advancements that bridge gaps and promote equal opportunities. The AIoT-powered smart specs not only illuminate the world for the visually impaired but also exemplify the potential of technology to create meaningful solutions. By harnessing the power of artificial intelligence and the Internet of Things, these smart spectacles signify a harmonious fusion of innovation and empathy, illustrating how technology can be harnessed to uplift and empower diverse segments of our community. This visionary solution stands as a testament to the positive impact technology can have on the lives of individuals, reaffirming our commitment to a more inclusive and technologically enriched future for all.

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