
Assistive Mobile Device for Visual Impaired Individuals – A Review

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Abstract: *Millions of people worldwide are affected by visual impairment, a persistent global challenge that significantly hinders mobility, independence, and quality of life. Conventional mobility aids, such as white canes, provide only minimal support for environmental awareness and navigation. Moreover, many existing intelligent assistive technologies are expensive, reliant on energy, and inaccessible to individuals in low- and middle-income countries. By integrating intelligent sensing with sustainable energy technologies, this study aims to develop a dual-powered smart assistive mobile device for visually impaired individuals, with the objective of improving safe navigation, autonomous mobility, and environmental awareness. To identify obstacles and provide navigation assistance, the proposed system integrates embedded systems, ultrasonic sensors, water sensors, day-night sensors, Internet of Things (IoT) components, and real-time feedback mechanisms. To ensure continuous operation and improved energy stability, especially in regions with unreliable power grids, the device features a dual-power architecture that combines solar energy with a rechargeable battery.*

Keywords: visual impairment, mobility independence, safe, navigation

INTRODUCTION

Visual impairment is among the most common disabilities globally, impacting millions of people and substantially restricting their capacity to carry out daily tasks independently [1,5,10,11]. The World Health Organization (WHO) defines visual impairment as a broad spectrum of vision conditions, including low vision and blindness, that can result from congenital disorders, diseases, injuries, or age-related degeneration [10,11]. Individuals with visual impairments frequently face challenges in navigating their environments, recognizing objects, reading printed text, accessing information, and interacting independently with their surroundings [2,3].

The swift evolution of mobile technology has revolutionized how people communicate, retrieve information, and carry out everyday activities. Smartphones and mobile devices have transformed from simple communication tools into powerful assistive technologies capable of supporting individuals with disabilities [1,12,13,15]. By integrating sensors, cameras, Global Positioning System (GPS), Artificial Intelligence (AI), machine learning, voice recognition, computer vision, and internet connectivity, mobile devices can offer real-time assistance to visually impaired users [4,9,14,16].

Assistive mobile devices are specifically designed or adapted to enhance the independence, mobility, safety, accessibility, and quality of life of individuals with visual impairments [1,2,12]. These devices are capable of performing a range of functions, including obstacle detection, navigation assistance, object identification, text-to-speech conversion, facial recognition, and emergency communication [3,4,9,14]. The integration of intelligent sensing and mobile technologies enables users to obtain important information about their surroundings through auditory, speech-based, or haptic feedback [2,3,4].

The growing accessibility and cost-effectiveness of mobile technologies have contributed to the increasing adoption of assistive solutions for visually impaired individuals [1,8,12,13]. Recent studies have concentrated on developing smart assistive mobile devices that integrate multiple technologies to provide more comprehensive and intelligent support for users [4,6,9,14]. The goal of these devices is to reduce reliance on caregivers, improve accessibility and independent mobility, enhance safety, and foster social inclusion [1,2,6,13].

Even with notable progress in the development of assistive technologies, several challenges persist concerning system accuracy, affordability, energy consumption, usability, reliability, and the ability of devices to function effectively across varied environmental conditions [2,4,7,8,9]. Environmental factors, sensor limitations, processing requirements, battery capacity, and differences in user needs may affect the practical performance and adoption of assistive mobile technologies [3,4,7,18]. Therefore, continued research and development are necessary to produce more reliable, affordable, energy-efficient, and user-friendly assistive systems.

This review explores the development, technologies, applications, benefits, and challenges associated with assistive mobile devices designed for visually impaired individuals. It highlights recent advancements, identifies current limitations and research gaps, and explores future pathways for improving the effectiveness of assistive technologies in promoting independent mobility, safety, accessibility, social inclusion, and an improved quality of life for individuals with visual impairments [1,4,6,12,13].

BACKGROUND OF THE STUDY

Vision is fundamental to how humans interact with their environment, allowing them to perceive objects, navigate spaces, recognize their surroundings, and carry out daily tasks efficiently. When

vision is partially or completely lost, individuals encounter a wide range of challenges that impact their mobility, communication, education, employment prospects, independence, and overall quality of life [2,5,10,11]. Globally, visual impairment continues to be a major public health challenge, especially in developing and low- and middle-income countries where access to specialized medical care, rehabilitation services, and assistive technologies is often restricted [1,5,8,10].

Traditionally, visually impaired individuals have depended on standard mobility aids, including white canes, guide dogs, and human support, to move around their environments [2,3]. Although these aids have demonstrated significant utility, they are not without limitations. For instance, white canes mainly detect obstacles within their physical range and may miss certain overhead obstacles, whereas guide dogs demand significant training, care, and upkeep [2,3,9]. These constraints have necessitated the development of more sophisticated technological solutions capable of delivering improved environmental awareness, obstacle detection, navigation assistance, and autonomous mobility [3,4,9,18].

The advent of mobile computing technologies has created new opportunities for assistive applications designed for visually impaired individuals. Modern smartphones and intelligent mobile devices are outfitted with sophisticated components, including advanced sensors, cameras, wireless communication systems, accelerometers, gyroscopes, Global Positioning System (GPS) modules, and powerful processors that enable intelligent assistive functions [4,14,15]. Researchers and developers have utilized these technologies to build mobile assistive systems that enable visually impaired individuals to recognize objects, read printed text, identify currency and other items, navigate unfamiliar settings, obtain location information, and detect or avoid obstacles [2,4,9,15,16].

The capabilities of assistive mobile devices have been further enhanced by emerging technologies such as Artificial Intelligence (AI), Computer Vision, Machine Learning, and the Internet of Things (IoT) [4,6,14,16]. These technologies allow devices to acquire and process environmental and visual information in real time, interpret surrounding conditions, identify objects, and deliver appropriate assistance to users [4,14,16]. The processed information can then be communicated through auditory, speech-based, or haptic feedback, enabling users to receive important environmental information without depending solely on visual perception [2,3,4]. Consequently, visually impaired individuals may be able to carry out daily tasks with greater independence, confidence, and safety [1,6,13].

Despite the increasing number of assistive mobile devices and applications, there remains a need to comprehensively evaluate their effectiveness, accessibility, affordability, reliability, and usability [1,4,8,13]. Various studies have reported different technological approaches, including ultrasonic sensing, computer vision, GPS-based navigation, artificial intelligence, machine learning, and mobile computing technologies [3,4,7,9,14,18]. However, these systems differ in terms of accuracy, cost, energy consumption, processing requirements, environmental

adaptability, and ease of use, which can influence their practical performance and adoption by visually impaired users [2,4,7,8,9].

Given the diversity of existing approaches and technologies, it is necessary to review the available literature to identify current trends, technological strengths, existing limitations, research gaps, and future research opportunities [4,6,9,14]. Such an evaluation can contribute to the development of more reliable, affordable, accessible, energy-efficient, and user-friendly assistive mobile technologies.

Consequently, this review aims to offer a comprehensive examination of assistive mobile technologies designed for visually impaired users, focusing specifically on their underlying technologies, real-world applications, benefits, limitations, and their capacity to foster independent living, improved mobility, safety, accessibility, and social integration [1,4,6,12,13].

METHODS

A narrative review approach was employed. Relevant literature was sourced from Google Scholar, the Journal on Multimodal User Interfaces, and the International Journal of Engineering Research & Technology using keywords such as "visual impairment," "mobility independence," "safe," and "navigation."

RESULTS AND DISCUSSION

i. In their 2010 comprehensive survey of wearable obstacle avoidance systems, Dakopoulos and Bourbakis discovered that ultrasonic and camera-based technologies substantially enhance navigation for visually impaired users. Their study investigated a broad spectrum of electronic travel aids (ETAs) engineered to improve mobility by delivering real-time environmental data that surpasses the capabilities of conventional tools like the white cane. The authors emphasized that wearable assistive devices equipped with sensors and intelligent processing systems can significantly improve obstacle detection accuracy, user safety, and overall independence during navigation.

The survey found that ultrasonic sensors are among the most frequently employed technologies in wearable systems, owing to their simplicity, cost-effectiveness, and efficacy in detecting obstacles at short to medium ranges. These sensors enable users to identify nearby objects prior to physical contact, which helps minimize collision risks and enhances reaction times. Furthermore, the relative ease of integrating ultrasonic-based systems into compact wearable devices makes them well-suited for practical assistive applications.

In summary, [3] demonstrate that combining ultrasonic and camera-based technologies significantly enhances mobility and safety for visually impaired users, while also emphasizing the need for ongoing advancements in sensor fusion and system optimization.

ii. In their 2017 review of intelligent assistive technologies for visually impaired individuals, Bhowmick and Hazarika concluded that combining multiple sensing technologies with real-time feedback mechanisms substantially improves mobility independence. Their study highlights that assistive systems achieve their greatest effectiveness when they can continuously gather environmental data via sensors like ultrasonic detectors, infrared sensors, and cameras, and subsequently process this information to deliver immediate and meaningful feedback to the user. The authors emphasize that integrating sensors is vital for enhancing both the accuracy and reliability of assistive devices. By integrating various sensor types—such as proximity sensors for obstacle detection and camera systems for environmental interpretation—assistive technologies can overcome the limitations inherent in using individual sensors. In summary, [2] found that integrating sensors with real-time feedback is crucial for creating effective assistive mobility systems, as this combination markedly enhances navigation precision, safety, and independence for visually impaired individuals.

iii. In their 2025 study, [4] investigated vision-based assistive technologies and found that AI-driven navigation systems markedly enhance both obstacle detection accuracy and general environmental awareness for individuals with visual impairments. Their research underscores that contemporary assistive technologies are increasingly dependent on computer vision and deep learning algorithms to process real-time visual data from the surrounding environment. By analyzing images and video streams with trained AI models, these systems can precisely detect and categorize essential environmental elements—such as pedestrians, vehicles, doors, and stairs—that are vital for ensuring safe navigation.

The authors also note that AI-driven navigation systems improve obstacle detection by employing sophisticated methods like convolutional neural networks (CNNs), object detection frameworks, and scene segmentation models. These methods enable the system to not only detect the presence of obstacles but also identify their type, distance, and relative position. In summary, [4] show that AI-driven vision-based assistive systems are vital for enhancing navigation precision, environmental awareness, and independent mobility among visually impaired users.

iv. Akram and colleagues. A 2025 study highlighted significant gaps in the accessibility of assistive technology within low- and middle-income countries, noting that affordability, usability, and infrastructural constraints continue to pose major obstacles to broad adoption. Their study emphasizes that while assistive technologies have made significant strides in functionality and intelligence, many of these innovations fail to effectively reach the populations that need them most. This is primarily attributed to elevated production expenses, dependence on sophisticated components, and constrained local manufacturing capabilities, all of which drive up the final cost of assistive devices, rendering them unaffordable for many users in developing regions. The authors also highlight that affordability represents one of the most significant barriers to the adoption of assistive technology. In many low-income areas, people with visual impairments frequently rely on simple tools like the white cane because advanced electronic assistive devices

are often too expensive. Even with the availability of such technologies, high maintenance costs and insufficient technical support continue to deter consistent use. This results in a substantial gap between technological progress and practical accessibility.

Overall, the findings by [5] highlight the urgent need for affordable, simple, energy-efficient, and context-appropriate assistive technologies. Bridging these gaps is crucial to guarantee that progress in assistive technologies leads to tangible enhancements in independence, mobility, and quality of life for visually impaired people living in low- and middle-income countries.

v. [6] emphasized the role of intelligent assistive systems in fostering social inclusion and independent living for visually impaired individuals. Their study highlights that modern assistive technologies have evolved beyond mere mobility support into comprehensive systems that facilitate participation in social, educational, and economic endeavors. By combining artificial intelligence, sensor technology, and real-time feedback, intelligent assistive systems help close the gap between disability and full participation in society. The authors explain that social inclusion is heavily dependent on the capacity of visually impaired individuals to interact effectively with their surroundings and the people within them. Intelligent assistive systems facilitate this by enhancing communication, navigation, and information access. For example, capabilities like voice-guided navigation, object recognition, facial identification, and text-to-speech conversion enable users to participate in social interactions and navigate public spaces with greater confidence. These capabilities lessen reliance on caregivers and boost independence in everyday tasks.

Overall, [6] demonstrate that intelligent assistive systems are vital for empowering visually impaired individuals by enhancing their mobility, communication, and societal participation, ultimately fostering greater independence and social inclusion.

While existing research confirms the efficacy of intelligent assistive technologies, few studies have specifically addressed the integration of dual-power systems into assistive mobility devices. This identifies a significant research gap that the current study aims to address.

CONCLUSION

The reviewed paper demonstrates that assistive technologies have significantly improved the mobility, safety, independence, and social inclusion of visually impaired individuals. Studies by [3] established the effectiveness of wearable obstacle avoidance systems that utilize ultrasonic and camera-based technologies to provide real-time environmental awareness and enhance navigation safety. Similarly, [2] emphasized the importance of integrating multiple sensing technologies with real-time feedback mechanisms to improve navigation accuracy and system reliability.

Recent advancements in artificial intelligence and computer vision have further transformed assistive mobility systems. [4] showed that AI-powered vision-based systems can accurately recognize obstacles, interpret environmental conditions, and provide intelligent navigation

assistance, thereby enhancing users' situational awareness and independent mobility. Furthermore, [6] highlighted that intelligent assistive systems contribute not only to mobility support but also to social participation, communication, and independent living, ultimately promoting greater inclusion of visually impaired individuals in society.

Despite these technological advancements, [5] identified significant challenges that limit the adoption of assistive technologies, particularly in low- and middle-income countries. Issues such as high costs, limited accessibility, inadequate technical support, and infrastructural constraints continue to prevent many visually impaired individuals from benefiting from modern assistive solutions. These findings suggest that future assistive technologies should focus not only on functionality and intelligence but also on affordability, energy efficiency, ease of use, and adaptability to local environments.

Overall, the paper confirms that intelligent assistive systems have considerable potential to improve the quality of life of visually impaired individuals. However, a notable research gap exists regarding the integration of dual-power systems in assistive mobility devices. Most existing studies focus on sensing, navigation, and artificial intelligence capabilities, while limited attention has been given to developing reliable power management solutions that ensure continuous device operation in environments with unstable power supply. Therefore, the development of a dual-powered intelligent assistive mobile device represents a valuable research direction that could enhance device reliability, accessibility, and usability, particularly in resource-constrained settings.

FUTURE DIRECTION

Future research should focus on:

- i) Integration of GSM module (SIM800L) for SMS alerts when WiFi is unavailable
- ii) Addition of voice feedback system for audio guidance
- iii) Use of AI-based object recognition camera for better obstacle detection
- iv) Implementation of mobile application for easier monitoring
- v) Integration of fall detection sensor for emergency situations
- vi) Improvement of waterproof casing for outdoor durability

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➤ Conflict of Interest

The author declares no conflict of interest

REFERENCES

- [1]. World Health Organization. (2024). *Global report on assistive technology*.
- [2]. Bhowmick, A., & Hazarika, S. M. (2017). An insight into assistive technology for visually impaired individuals. *Journal on Multimodal User Interfaces*, 11(2), 149–172.
- [3]. Dakopoulos, D., & Bourbakis, N. G. (2010). Wearable obstacle avoidance electronic travel aids for blind people. *IEEE Transactions on Systems, Man, and Cybernetics*, 40(1), 25–35.
- [4]. Yao, F., Zhou, W., & Hu, H. (2025). A review of vision-based assistive systems for visually impaired people: Technologies and applications.
- [5]. Akram, R., Buis, A., Sultana, M., Lauer, J. A., & Morton, A. (2025). Mapping gaps and exploring impairment and disability prevalence in low- and middle-income countries. *Disability and Rehabilitation: Assistive Technology*.
- [6]. Nombakuse, R., Messerschmidt, N., Tsibolane, P., & Khalid, M. I. (2025). Intelligent assistive technologies and social inclusion for visually impaired people. *Information Systems Research*.
- [7]. Apprey, M. W., Agbevanu, K. T., Gasper, G. K., & Akoi, P. O. (2022). Design and implementation of a solar powered navigation technology for the visually impaired. *Sensors International*, 3, 100181. <https://doi.org/10.1016/j.sintl.2022.100181>.
- [8]. Borg, J., Östergren, P. O., Larsson, S., Rahman, A. A., Bari, N., & Khan, A. N. (2022). Assistive technology use and affordability in low-income countries. *Disability and Rehabilitation: Assistive Technology*.
- [9]. Technological advancements in human navigation for the visually impaired: A systematic review. (2023). *Sensors*, 25(7), 2213. <https://doi.org/10.3390/s25072213>.
- [10] World Health Organization (WHO): Blindness and Vision Impairment. (2026). *Blindness and vision impairment*. World Health Organization. Retrieved June 8, 2026.
- [11]. World Health Organization (WHO): Eye Care, Vision Impairment and Blindness. World Health Organization. Retrieved June 8, 2026.
- [12]. World Health Organization (WHO): Assistive Technology. World Health Organization. Retrieved June 8, 2026.
- [13]. World Health Organization (WHO): Assistive Technology Fact Sheet. (2024). *Assistive technology*. World Health Organization.
- [14]. Fulong Yao, Wenju Zhou, & Huosheng Hu. (2025). *A review of vision-based assistive systems for visually impaired people: Technologies, applications, and future directions*. arXiv.
- [15]. Martin Weiss, Margaux Luck, Roger Girgis, et al. (2018). *A survey of mobile computing for the visually impaired*. arXiv.
- [16]. Linda Wang, & Alexander Wong. (2019). *Implications of computer vision driven assistive technologies towards individuals with visual impairment*. arXiv.
- [17]. Bhanuka Gamage, Leona Holloway, et al. (2025). *Vision-based assistive technologies for people with cerebral visual impairment: A review and focus study*. arXiv.
- [18]. Kumar, A. and Singh, R. (2022) ‘Design and development of smart blind stick using ultrasonic sensors’, *International Journal of Engineering Research & Technology*, 11(5), pp. 112–118

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