Breaking Barriers: AI Tools for Academic Libraries to Improve Equitable Access to Information Resources for Visually Impaired Users

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Abstract

With the advent of ICT and ease of internet accessibility, academic libraries offer a plethora of information resources such as print, digital, electronic, and web-based formats. However, despite technological advancements, an estimated 2.2 billion visually impaired persons (VIPs) worldwide encounter significant barriers in accessing necessary information for personal, academic, and professional development (WHO, 2023). VIPs require access to information for education, empowerment, and leading dignified lives, like sighted persons. Yet, due to inaccessible formats or prolonged waiting periods for accessible resources, VIPs often face challenges in accessing information promptly and reliably. So, this paper delves into the potential of Artificial Intelligence (AI)-powered Assistive Technology (AT) tools in academic libraries to address this issue by facilitating equitable access to information resources for VIPs. Through an exploration of AI integration benefits, features, and associated challenges, the paper aims to provide insights into leveraging AI-supported AT tools effectively to ensure universal access to information. Specifically, it examines various AI tools such as Be My Eyes, Seeing AI, Envision AI, TapTapSee, and Google Lookout, alongside strategies for their implementation in academic libraries to enhance accessibility for visually impaired users.

Keywords: Inclusive Library, Equitable Access, AI Tools, Divyang, Visually Impaired Persons

1. Introduction

In academic institutions, the library plays a crucial role in acquiring, storing, and disseminating the right information, to the right users, at the right time, in the right amount, and in the right professional way to fulfill the information needs of their teachers and students. It is also observed that access to information resources plays a crucial role in facilitating teaching, learning, and research activities. However, for Visually Impaired Persons (VIPs), traditional methods of accessing printed resources pose significant challenges. Currently, most academic libraries in developing nations are functioning in conventional mode with limited ICT and infrastructure facilities that could not be very helpful in accommodating VIPs into mainstream library services. Consequently, VIPs are not able to utilize the library facility at the maximum level and the

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information stored in the form of printed books and journals has become out of reach for VIPs which leads to high dropout ratio, disappointment and frustration. The Right of Persons with Disabilities (RPWD) Act of 2016 advocates that VIPs have an equal right to access the same information resources, services, and facilities of academic libraries, which everyone deserves (Government of India, 2016). Additionally, the American Library Association (ALA) council strongly recommended that academic libraries ensure equitable access to library resources, services, and products and use strategies based on the principles of universal accessibility of information to ensure that library policy, resources, and services meet the needs of all people (ASGCLA, 2016). So, to implement the RPWD and ALA guidelines in academic libraries, there is an urgent need of re-engineering library resources, infrastructure and ICT tools to amalgamate VIPs in mainstream library facilities and provide them equitable access to library resources, services and other facilities. Therefore, academic libraries must explore new cutting-edge technology such as assistive technologies that can serve as a solution to these accessibility challenges, breaking down barriers and fostering equitable access to information resources in academic libraries.

1.1 Challenges Faced by VIPs

Like sighted persons, VIPs are valuable parts of our society and have the same information needs, and an equal right to access information (Government of India, 2016). Additionally, due to their impairment, VIPs cannot read the printed resources on their own and require a conducive format of information resources such as Daisy, Audio, Digital, Braille, Large Print, Tactile format, etc (Aniekwe, Calista Chinyere; Ogwo, Uzoamaka; and Ayolugbe, 2022). However, it was observed that there was an acute shortage of conducive formats of information resources in most academic libraries, especially in developing countries and consequently VIPs have to depend on the mercy of their sighted peers or NGOs (Adetoro, 2014). It was also revealed that most VIPs could not access necessary information as and when required and had to wait for a long time to get the information needed in their accessible format, and that, too, was not for sure (Singh & Gupta, 2023). Additionally, it was also revealed that most visually impaired students depend on their respective libraries to fulfill their information needs because the conducive format of information resources is not easily available in the market (Khowaja & Fatima, 2023). Another study revealed that cent percent of VIPs were dependent on library facilities and required support of library staff to access and use library resources for their academic needs (Kori & Mulla, 2022; Euriel Uzohue & Abdulazeez Yaya, 2016). However, most academic libraries are not equipped with a conducive format of information resources, trained library professionals and adequate technologies to facilitate VIPs effectively. Consequently, it created a massive gap between the availability of information in the public domain and making it accessible for VIPs. So, this study suggested that existing academic library facilities should be redesigned and modified with the latest assistive technologies to enable VIPs to access and use library resources efficiently (Dhara, 2015).

1.2 Role of ATs in Academic Libraries

ATs encompass a wide range of hardware, software, and equipment designed to improve, increase, and maintain the functional capabilities of Divyang, also referred to as persons with disability or differently-

abled persons. These technologies enable them to overcome daily life challenges related to seeing, hearing, speaking, moving, remembering, and more, by assisting them in tasks that might otherwise be difficult or nearly impossible. Within academic libraries, ATs play a crucial role in assisting VIPs to access and utilize library resources effectively and conveniently. A significant aspect of ATs in academic libraries involves enhancing the accessibility of library resources by providing alternatives to traditional print materials (Phukubje & Ngoepe, 2017). Software tools like screen readers, text-to-speech, scanning and reading, and screen magnification software empower VIPs to independently access print, digital, electronic, and web-based information resources (Majinge & Stilwell, 2014). Braille display and scanning and reading devices offer tactile feedback, enabling students to interact with textual information autonomously. Optical character recognition (OCR) software further enhances accessibility by transforming printed text into digital formats, which can be outputted through speech or Braille. Additionally, navigation aids such as tactile maps and audio guides assist students in navigating library spaces, locating resources, and accessing library services effectively. By integrating appropriate ATs into academic libraries, institutions foster an inclusive learning environment where VIPs can confidently engage with scholarly resources and pursue their academic goals with independence and assurance (Ilako, Maceviciute, & Muwanguzi, 2020) . A scholar found that the majority of VIPs need some form of ATs hardware or software to access print and electronic resources (Willings, 2020). So, AT is a boon for VIPs to be self-sufficient in accessing the required information on time.

2 Objectives of the Study

The following are the objectives of the study:

1. Assess the current landscape of assistive technologies (ATs) and AI tools utilized in academic libraries to support visually impaired users.
2. Evaluate the effectiveness and usability of existing AI tools and ATs in enhancing equitable access to information resources for VIPs.
3. Explore the preferences, needs, and challenges of VIPs regarding AI tools and ATs within academic library environments.
4. Investigate the potential integration of emerging AI technologies to address existing gaps and further improve accessibility for VIPs.

3 Scope of the Study

The study aims to investigate various AI technologies and their applications in addressing the challenges faced by VIPs in accessing and utilizing library resources effectively. It will delve into the functionalities and effectiveness of AI-driven tools such as Be My Eyes, Seeing AI, Envision AI, TapTapSee, and Google Lookout in facilitating equitable access to print, digital, electronic, and web-based resources. The research will also examine the integration of AI tools with existing assistive technologies to create seamless and inclusive library environments for VIPs. By examining the potential benefits and challenges associated with

AI adoption in academic library contexts, the study aims to provide insights and recommendations for enhancing accessibility and promoting equitable access to information resources for VIPs, thereby contributing to the advancement of inclusive practices within academic institutions.

4 Research Methodology

The study undertakes a comprehensive literature review to investigate the role of AI tools in academic libraries for visually impaired persons (VIPs). Initially, an exhaustive literature search was conducted to identify existing AI technologies and their specific applications within academic library settings, with a focus on their impact on accessibility for VIPs. This process involves analyzing research papers, abstracts, reports, newsletters, product descriptions, and reviews published in leading research journals and newsletters, including Emerald, Taylor & Francis, Sage, Elsevier, DESIDOC, and the American Institute of Science, etc. Additionally, the websites of prominent organizations such as Freedom Scientific, VisionAid International, HumanWare, KritiKal Solutions, Trestle Labs, The American Foundation for the Blind and the National Institute for the Empowerment of Persons with Visual Disabilities were visited to gain insights into AI-enabled assistive hardware and software beneficial for academic libraries to serve VIPs (Humanware, n.d.; Kritikal Solutions, n.d.; Trestle Labs, n.d.; VisionAid, n.d.). Finally, 30 sources published between 2014 and 2024 were selected for the study to understand current trends and developments in AI tools for VIPs.

5 AI Tools for Academic Libraries

Artificial Intelligence (AI) plays a significant role in improving the independence, accessibility, and quality of life for VIPs. By leveraging AI algorithms and techniques, various AT hardware and software have been developed to address the specific challenges faced by VIPs in their personal and professional life. These AI-powered AT tools can overcome barriers and provide innovative solutions to empower VI users to engage fully in academic, workplace, and social interactions and daily activities. In academic libraries, AI can be used to enhance the accessibility of library space and improve the experience of VI users in accessing library resources, services and other facilities. Here are some examples of AI-enabled hardware and software that are useful for VI users in utilizing library facilities:

- **Seeing AI**: This app is designed by Microsoft Corporation to empower VIPs in reading print text and recognising other objects. It serves as a comprehensive solution utilizing a device's camera to offer detailed descriptions of the surroundings to VI users. In the context of an academic library, it can be used for reading a diverse range of content including short texts, documents, product labels, individuals, landscapes, currency, light, colours, and even handwriting. Additionally, it boasts the capability to scan product barcodes and articulate their descriptions aloud, enhancing accessibility and independence for users with visual impairments (Microsoft, 2017).

- **Be My Eyes**: This is an AI-powered app that establishes connections between visually impaired (VI) persons and sighted volunteers who can guide them through live video calls in various daily tasks

such as reading labels and navigating unaccustomed surroundings. This innovative platform harnesses the power of technology and human kindness to empower VIPs, fostering a community of support and inclusion. In a library setting, it links VI users with sighted volunteers who can aid in various tasks such as finding books, reading titles, and navigating the library environment (Wiberg, 2015).

- **Envision AI:** This app is powered by AL that provides enhanced accessibility, autonomy, and ease to individuals with low vision and blindness, enriching their daily experiences. It uses advanced text recognition, image recognition, and text-to-speech technologies to provide real-time information about the environment, objects, text, and more (Envision Enterprise, 2022).

- **TapTapSee**: This app enables VIPs to take a photograph of any object or text, and through AI image recognition technology, it provides an audible description of the object or text. In the library, it enables VI users to capture images of library resources, such as book covers or labels, translating visual information into audio descriptions. It helps VI users to identify and obtain information about their surroundings (CloudSight, 2012).

- **Lookout**: Google developed this application with the primary goal of offering immediate support to visually impaired (VI) users by enabling real-time object recognition, document scanning, and reading aids. Leveraging the power of AI and computer vision facilitates more efficient navigation of surroundings for VI individuals. Moreover, it empowers users to capture and audibly interpret both short text excerpts and lengthy documents through scanning and text-to-speech conversion. Additionally, the app is equipped to detect and audibly signal the presence of individuals in the nearby environment, enhancing VI users' ability to identify those around them (Google LLC, 2018).

- **Speechify Text Reader:** This application is specifically designed and developed to aid VIPs in accessing and comprehending digital text materials. It is conveniently available as both a mobile app and a desktop application compatible with Windows and macOS operating systems. Leveraging advanced text-to-speech technology, the app offers a range of accessibility functions, transforming written content, including eBooks, articles, documents, and webpages, into spoken words for ease of use by VI users. Moreover, it boasts multilingual support and customizable features such as adjustable reading speed, voice options, and text highlighting. Facilitating seamless synchronization and progress tracking across multiple devices, users can effortlessly transition between platforms while maintaining continuity in their listening experience. Furthermore, the app integrates various accessibility enhancements such as voice commands, intuitive gestures, and compatibility with screen readers, ensuring an intuitive and inclusive user experience for VI individuals (Weitzman, 2022).

- **Drishti**: Accenture developed this application to provide smartphone-based support for VIPs. It integrates advanced technologies including image recognition, natural language processing, and natural language generation. By utilizing the smartphone's camera, it conducts real-time image recognition to describe the surrounding environment audibly to the VI user. Through sophisticated natural language

processing, it offers spoken commentary on the user's surroundings, facilitating comprehension and navigation. Furthermore, the app is capable of identifying and narrating text from various sources such as books, documents, and currency notes. In addition to enhancing accessibility, it assists in identifying potential obstacles like glass doors, thereby contributing to the user's safety and seamless navigation (Accenture, 2017).

- **NavCog**: This is an AI-powered application designed to assist VI users in navigating indoor environments. Leveraging smartphone sensors like GPS, accelerometers, and beacons, in tandem with advanced AI algorithms, it furnishes step-by-step guidance, identifies points of interest, and delivers comprehensive navigation support (Gonzalez, 2020).

- **Smart Glasses**: This is a wearable device that utilizes AI technology to interpret diverse visual cues and relay the information audibly to VIPs. It empowers VI users to comprehend their surroundings, including people and objects, without external assistance. It also facilitates independent mobility, enabling VI users to navigate, read text, and identify individuals autonomously. Notable examples of smart glasses include IrisVision electronic glasses, Acesight, NuEyes Pro, MyEye2, and AIRA (IrisVision Global, 2020).

- **PeopleLens**: This is a high-end AI system that enables VIPs to achieve greater independence in comprehending social environments and actively engaging in social interactions. It operates through a cutting-edge wearable augmented reality device, integrating advanced computer vision algorithms to consistently identify the positions, identities, movements, and eye gazes of nearby individuals. Representing a groundbreaking advancement for VI users who often encounter barriers to social engagement due to their visual impairment, this device facilitates communication, navigation, object identification, and an enriched sensory experience akin to that of sighted individuals. Harnessing the power of artificial intelligence, the system incorporates advanced facial and object recognition technologies, empowering users to interact with their surroundings autonomously (Morrison, Jones, Grayson, & Cutrell, 2022).

- **NoorCam MyEye**: This is a wearable device powered by AI technology to support VIPs in reading text, recognising faces, identifying products, and providing real-time audio feedback about their surroundings. Through the integration of AI and a built-in camera, the device offers real-time auditory guidance, empowering users to engage with their surroundings autonomously. The device can be attached to eyeglasses and provides real-time audio feedback to the user (Noorcam, 2017).

- **Voice Assistants**: This system is tailored for VIPs to serve as a revolutionary tool, leveraging advanced technology to enhance accessibility and independence. It is designed with intuitive interfaces and speech recognition capabilities, these systems empower users to effortlessly navigate digital environments, access information, and perform daily tasks with ease. Through natural language processing, users can interact verbally, issuing commands and receiving spoken responses, effectively

bridging the gap between the visually impaired and digital interfaces. By providing auditory feedback and assistance in tasks such as reading text, managing schedules, or accessing information online, voice assistant systems enable visually impaired individuals to navigate the modern world with confidence and efficiency, fostering greater inclusivity and autonomy. It is very useful and can be integrated into library systems to provide audio-based access to library services to VIPs. With the help of this device, users can request information about book availability and due dates or ask for recommendations based on their preferences. Examples of AI-powered voice assistant devices are Amazon Alexa, Google Assistant, Apple Siri, and Microsoft Cortana (Upadhay, Upadhay, Ghosh, & Jha, 2019).

Table 1: AI-Powered Technology for VIPs

Sl. No	Name of Software	Developed By	Type	Purpose/Usage	Tentative Cost
1.	Be My Eyes	Be My Eyes	Mobile app	Assist in reading and identifying objects through live video calls.	Free (Android and iOS)
2.	Seeing AI.	Microsoft Corporation	Mobile app	Reading printed text and recognising objects.	Free (iOS)
3.	Envision AI	Envision	Mobile app	Provide real-time information about the environment, objects, text, and more.	Free (Android and iOS)
4.	TapTapSee	CloudSight Inc.	Mobile app	Provides an audible description of the object or text.	Free (Android and iOS)
5.	Lookout	Google LLC	Mobile app	Provide real-time assistance.	Free (Android)
6.	Speechify Text Reader	Speechify	Mobile app	Accessing and reading digital text content.	$12 /Monthly (Android and iOS)
7.	Drishti	Accenture	Mobile app	Describe the surrounding environment.	Free (Android and iOS)
8.	NavCog	IBM	Mobile app	Navigation support system	Free (iOS)
9.	PeopleLens	Microsoft	Hardware	Smart glasses	Not Specify
10.	OrCam MyEye	OrCam	Hardware	Providing remote assistance to access information.	$ 3500

6 Benefits

The use of AI tools in academic libraries holds immense potential for improving equitable access to information resources for visually impaired users. These tools enhance accessibility by providing alternative formats such as audio descriptions or text-to-speech capabilities, thereby making digital content more readily available.

Additionally, AI-driven technologies offer personalized support tailored to the specific needs and preferences of visually impaired users, including customized reading speeds, voice selections, and content highlighting, thereby enhancing the overall user experience. Furthermore, by enabling visually impaired users to independently access and navigate library resources, AI tools promote greater autonomy and reduce reliance on external assistance, fostering independence and engagement with information. Moreover, AI-powered search and navigation functionalities streamline the process of locating and retrieving information, saving time and effort for visually impaired users and enhancing overall productivity within academic environments.

7 Challenges

Ensuring the effectiveness of AI tools in academic libraries for visually impaired users involves overcoming several challenges. Accuracy and reliability are paramount, as AI algorithms must correctly interpret and convert text or visual information to avoid potential misunderstandings or accessibility barriers. Seamless compatibility and integration with existing library systems pose another hurdle, given the diversity of software and technologies used. Moreover, customizing AI tools to meet the diverse needs and preferences of visually impaired users while maintaining accuracy and efficiency presents a significant challenge. Ensuring data privacy and security, particularly concerning sensitive user information, is crucial yet complex, considering the vast amounts of data AI tools utilize. Lastly, providing adequate training and support for both users and library staff is essential to maximize the benefits of AI tools without encountering significant barriers or frustrations.

8 Conclusion

The rapid advancement of AI technology presents exciting opportunities to improve the accessibility of information resources for visually impaired persons (VIPs) in academic libraries. AI-driven tools empower VIPs to access, navigate, and engage with library resources more effectively, promising enhanced accessibility and personalized support. By facilitating efficient conversion, navigation, and assistance, AI tools signify a significant step towards inclusivity and autonomy for VIPs.

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