LIBRARY HERALD
Vol 60 No 4
December 2022

Assistive Technology: Hardware Devices for Academic Libraries to Provide Equitable Access to Information for Visually Impaired Persons

DALIP SINGH*
DINESH K GUPTA**

The primary purpose of this study is to evaluate the cutting-edge Assistive Technologies (AT) hardware devices that are useful for academic libraries to amalgamate Visually Impaired (VI) users into the mainstream of library services. In addition, the study also advocates and promotes the use of AT hardware devices in academic libraries, especially in developing nations, as the best possible solution for providing equitable access to information to VI users. This study found that only a few academic libraries in India have integrated a few essential ATs in the library to facilitate VI users. Consequently, most VI users are not getting equitable access to library resources and services, creating a wide gap between the availability of information in the public domain and its accessibility to VI users. The study enlists some AT hardware devices and their tentative costing, features and names of the vendors or suppliers, which may be very useful for academic libraries in procuring suitable AT devices and providing equitable access to library resources to VI users. This study focuses on AT hardware devices useful for VI users in academic libraries. The study highlights some state-of-the-art AT hardware devices that may create awareness among academic libraries interested in introducing suitable AT hardware devices for VI users. This study will be helpful for traditional libraries in the transition phase of becoming inclusive libraries and at the edge of finalising AT solutions to open their doors to VI users. This paper will also give library professionals an innovative idea on the latest AT hardware devices available in the market and would be a boon for improving the accessibility and usability of library resources for VI users.

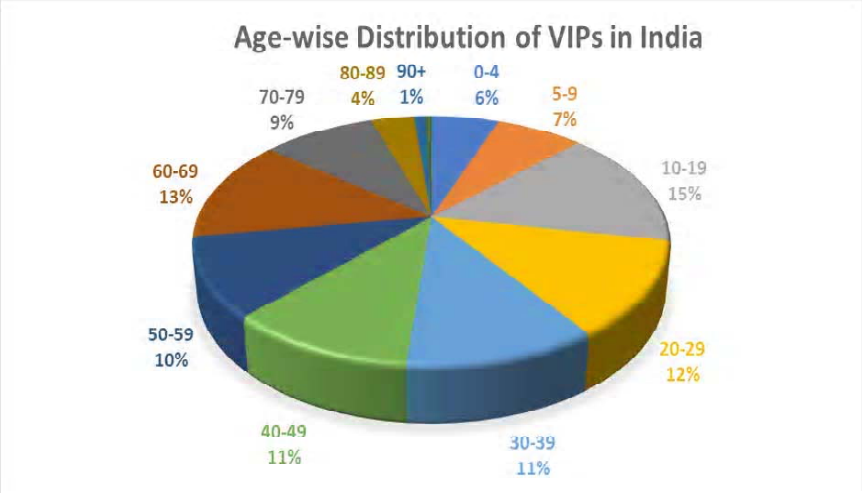
* Research Scholar, Dept. of Lib. Inf. Sc., Kurukshetra University, Kurukshetra

** Professor, Dept. of Lib. Inf. Sc., Kurukshetra University, Kurukshetra

Keywords: *Assistive Technology, Inclusive Library, Equal Opportunities, Divyangjan, Visually Impaired Persons, Blind, Low Vision*

1 INTRODUCTION

WHO estimated that globally almost 285 million persons experience vision impairment, out of whom 39 million are blind and 246 million have some sort of vision impairment[1]. Out of the total population of Visually Impaired Persons (VIPs), India has 62 million (21.75%) VIPs, out of whom 8 million are blind and 54 million have moderate to severe vision impairment[2]. According to the 2011 Census of India, Visual Impairment emerged as the second most disability that including 18.8% (50,33,431) of the total population of Differently-abled Persons (DAPs)



Source: *Table C 20, Census of India, 2011*

Figure 1: Age-wise Distribution of VIPs in India

It is found that India has 34.9% (17,55,213) of VIPs aged between 5 to 29 years. The literacy rate of VIPs is meagre (35%), the education completion rate is very low (3% graduate and above), and the economic status (37.5% employed) is below the average of the Nation's employment rate[3]. Therefore, they urgently need facilities for completing education, updating skill sets and finding suitable jobs for their livelihood. So, for the overall development of VIPs, India urgently needs to transform its traditional academic library system and equip them with adequate AT facilities to provide equitable access to library resources, services, and products to all users. However, so far, only a few academic libraries have opened their doors for VI users.

2 OBJECTIVES OF STUDY

This study explores the most appropriate AT hardware devices available in the market, especially in India, that can prove to be a stepping stone for academic libraries to empower and fulfil the information needs of VI users. It also suggests some AT hardware devices that can play a boon for academic libraries to enable VI users to be self-reliant in accessing and using library resources at their convenience.

3 SCOPE OF STUDY

This study focuses on the information needs of VI users, their key challenges in accessing library resources independently and how their information needs can be fulfilled to some extent with the support of computerised AT hardware devices. The study also tries to find the barriers between the availability of information in academic libraries and information accessed or used by VI users. Based on this, the study provides technology solutions that can be very helpful in setting up an inclusive library system and amalgamating VI users into mainstream library services.

4 INFORMATION NEEDS OF VI USERS

VI users also require the latest information to update, educate, empower and be self-sufficient like normal users. But due to the non-availability of information in a conducive format, they have to wait for a long time to get the information needed in their accessible format, and that too is not for sure, leading to disappointment and frustration. It also creates a massive gap between the availability of information in the public domain and making it accessible for VI users. Since there is an acute shortage of conducive format of information resources in academic libraries, VI users cannot access necessary information as and when required. A survey estimates that less than 0.5% of books are available in formats accessible by VI users [4]. Due to their disability, VI users cannot read print materials mostly available in academic libraries and require informational resources in a conducive format such as Daisy, audio, digital, Braille, large print, tactile resources, etc. So, equitable and efficient access to academic library resources plays a decisive role in the educational growth and empowerment of VI users. But most academic libraries, especially in developing nations, still follow traditional approaches to serving their patrons that are not helpful for VI users. The ALA council strongly recommended that academic libraries ensure equitable access to library resources, services, and products; and use strategies based upon the principles of universal accessibility of information to ensure that library policy, resources, and services meet the needs of all people [5].

5 LIBRARY FACILITIES FOR VI USERS

Academic libraries are an essential part and parcel of a sound education system and play a crucial role in providing quality education and making the teaching and learning process smooth and effective. Despite this, most academic libraries are not amalgamating VI users into mainstream library services due to a lack of VI-friendly infrastructure, adequate information resources in a conducive format and proper AT facilities. A study found that VI users face many challenges concerning academic libraries' physical and intellectual access [6]. Another study confirmed that VI students (India) experience poor information resources access mechanisms and less volume of course content in a conducive format [7]. Another study found that it is almost impossible for VI users to utilise library facilities independently due to physical and psychological barriers; and the inaccessibility of library materials [8]. It was also found that VI users face numerous obstacles when using library services due to the unavailability of required reading materials in convenient formats and the lack of modern AT facilities to support access to library resources and services [9]. Another researcher also confirmed an acute shortage of information resources for VI users in academic libraries worldwide, and the situation is worse in developing countries [10]. In the wake of this situation, on 28 December 2016, the parliament of India enacted the "Rights of Persons with Disabilities (RPwD) Act", which advocates equal opportunities, equal rights and full participation of differently-abled persons, including VI users in society [11]. The Act also emphasises that VI users have an equal right to access the same information resources, services, and facilities of academic libraries, which everyone deserves. Therefore, to implement the RPwD Act in schools, colleges, and universities, it has become mandatory that traditional academic libraries should be transformed into inclusive libraries to provide equitable access to library resources and services to all users, including VI users. So, to provide equitable access to a wide range of library resources to VI users, it has become mandatory for academic libraries to acquire appropriate AT hardware devices that can play a decisive role in providing access to print and non-print resources to VI users.

6 ASSISTIVE TECHNOLOGY FOR VI USERS

Assistive Technologies is a combination of hardware, software and other peripheral devices used to increase and maintain the functional capabilities of differently-abled persons, including VI users. In the context of academic libraries, AT plays a vital role in amalgamating VI users into mainstream library services and providing them equitable access to a wide range of library resources, including print and non-print resources. A study found that AT is essential for providing the required information services to Differently-abled patrons, and it helps them retrieve and apply information for their educational

needs 12. Another study revealed that academic libraries must provide an accessible environment for all patrons and deploy adequate Assistive Technologies to provide equitable access to the library resources and facilitate Differently-abled users 13. It is also suggested that AT is urgently needed in academic libraries to enhance and improve information accessibility for Differently-abled persons 14. It promotes greater independence by enabling VI users to reach library premises, visit different sections, and access various information resources like normal users.

7 AT HARDWARE DEVICES

AT hardware devices are pieces of equipment that work like the eyes, legs, ears, and voice of VI users. These devices can improve VI users' capability, performance, achievement, and independence in academics, workplaces, and daily living. It is also noticed that VI users who have access to the appropriate AT devices are more successful in their respective areas than others. AT devices like a Refreshable Braille Display, Braille Printer/ Embossers, Scanning and Reading Device, Daisy Players, etc., are very useful for blind users to access the required information from library resources independently for their academic growth. Devices such as Portable Electronic Magnifiers, Desktop Magnifiers, and Large Print Keyboard are very beneficial for low-vision users.

71 REFRESHABLE BRAILLE DISPLAY

It is an electronic device that can be attached to a laptop/computer keyboard. It provides access to information on a computer screen by electronically raising and lowering different combinations of Braille cells' pins.

Figure 2: Refreshable Braille Display 15

This device is available in various models, such as 40, 70 and 80 characters. It can display up to 80 characters from the computer screen. The device may also be used as an input device. It has a refreshable feature that changes continuously as the user moves the cursor around on the screen. It provides direct access to information and allows VI users to check format, spacing and spelling. The device is interfaced with Braille Embossers to produce a hard

copy 16.

The following Refreshable Braille Displays of various categories are available in the market:

Name of Device	Features
DotBook **Mfr[1]:** KritiKal Solutions Pvt Ltd **Model** **T.Cost[2]** 40Q □60,000 20P □40,000	It is a feature-packed, user-friendly and cost-effective device. It enables VI users to access and manage digital content easily. It aims to empower VI users to streamline the procedure of reading & writing. It is powered by rechargeable batteries and supports Bluetooth/USB/ Wi-Fi connectivity with computers and smartphones. Its 40-cell Braille variant comes with a QWERTY Keyboard, and 20 cell Braille variant comes with Perkins Keys for Input [15].
Seika V3 **Mfr:** Nippon Telesoft **T.Cost: □143000**	It is lightweight and compact, specially designed to carry easily. It has a highly stable and accurate display system of eight dots, and a display capacity is 40 cells. It is compatible with most screen-reading software such as Jaws and Window-eye. It has the interface support of a USB power source connection, so it does not require an additional adapter [17].
Brailliant BI **Mfr:** HumanWare **Model** **T.Cost** 14 $1245 20X $2099 40X $3499 Mantis Q40 $2695	It easily fits on a laptop or desktop keyboard and supports various file formats such as doc, docx, txt, pdf, etc. Users can personalise the main menu, configure the thumb keys, and adjust the auto-scroll speed. It is available in 14, 20, and 40 cells refreshable displays to improve reading comfort. The device can easily be connected via Bluetooth to a smartphone and read the information available in digital format [18].
TacRead **Mfr:** IIT, Delhi **T.Cost:** Not Specified	It is lightweight and has a long life. It supports Bluetooth connectivity and can read Word and PDF documents. It has a user-friendly Braille keyboard and effortless navigation [19].
Smart Beetle **Mfr:** HIMS Inc **T.Cost:** $1195	It supports a qwerty keypad and is ultra-portable and lightweight. With most screen readers, it can be compacted. It's available in 14 cell displays [20].
Braille EDGE 40 **Mfr:** HIMS Inc **T.Cost:** $2995	It has a Perkins-style qwerty keyboard and Braille note-taking facility. It is compactable with most screen readers and has USB and Bluetooth connectivity. It is equipped with Notepad, Scheduler, Alarm, Clock, Calculator, Stopwatch, and Countdown timer applications [21].
Focus 40 Blue **Mfr:** Freedom Scientific **T.Cost:** $2995	It is lightweight, user-friendly and supports Windows, Mac, and smartphones. It is compactable with JAWS screen readers and has a menu button for quick access to settings [22].

Table 2: Refreshable Braille Display

72 BRAILLE PRINTER/EMBOSSER

It receives data from a computer and embosses that information in Braille on heavyweight paper. Braille printers are very useful in making written documents accessible for VI users.

Figure 4: Braille Printer

(Santarelli, 2019)

The following is a list of a few Braille Printers/ Embossers that are available in the market and are very useful for libraries for printing Braille documents:

Table 3: Braille Embossers/Printers

Name of Device	Features
Everest-D V5 **Mfr:** Index Braille **T.Cost: 316000**	It is the most popular embosser and embosses high-quality Braille on cut-sheet paper in any format. It can print in double-sided or four-page booklet format. It can print 140 characters per second and automatically feed the sheet. It has Braille and text labelled control panel. It is the most flexible printer and supports heavy Braille printing [24].
Braillo Braille **Mfr:** Braillo **Model** **Cost** 300 S2 $24213 450 S2 $34013 600 S2 $43237 650 SF2 $126830	It is the most reliable, affordable and superior-quality braille output device. It comes in four models, and based on the model, it can print Braille output at 300 - 650 characters per second [25].
Basic-D V5 **Mfr:** Index Braille **T.Cost:** $3695	It is a double-sided braille printer and can emboss 140 characters per second. It has Braille and text labelled control panel. It can print horizontal and vertical Braille [26].
Braille Express150 **Mfr:** Florida Vision Technology **T.Cost:** $16995	It is a high-quality and reliable Braille printer. It can print 150 characters per second or 500 Braille pages per hour. It has 500-page memory and a built-in multi-copy feature [27].
Gemini Super Braille Embosser **Mfr:** HumanWare **T.Cost:** $8900	It can print Braille and ink characters in parallel lines on the same page. It can also print 36 Braille characters and 90 ink characters per second. It also allows printing ink characters twice the standard size and changing the font types and position of the character above and below the braille lines [28].
VP Columbia 2 **Mfr:** Viewplus **T.Cost:** $3495	It is a double-sided braille embosser and can print 120 characters per second. It has a pin feed mechanism that pulls the paper continuously through the printer from the bottom to the top. It also supports Tiger Software Suite (Braille and tactile graphics software). It is available with Bluetooth and Wi-Fi connectivity [29].

73 DAISY PLAYER

The Digital Accessible Information System (DAISY) player is an electronic device used to playbooks in DAISY format. It is the format developed on the international standard for digital talking books. VI users widely accept this format at many libraries. It enables VI users to navigate the digital resources page by page and chapter by chapter.

Figure 5: DAISY Player

Table 4: Daisy Players

Name of Device	Features
Angel India **Mfr:** Karishma Enterprises **Model** **T.Cost** **Angel India Pocket Talking Daisy Player** □ 8000 **Angel Online Pocket Talking Daisy Player** □ 12970	It is an excellent pocket-talking Daisy player that enables visually impaired persons to read Daisy books and E-books. It allows recording class lectures for later listening to revision. It can play audio recordings of talking books, lectures, MP3 files, music etc. It can also insert bookmarks on essential points to support the learning and quick revising of the lessons. It is equipped with a talking calculator for instant arithmetic calculations [31].
Victor Reader **Mfr:** Humanware **Model** **T.Cost** **Victor Reader Stratus 12 M** $495 **Victor Reader Stratus 4 M** $455	It is a digital talking book player which supports the DAISY format. It is powered by easy navigation and allows you to reach specific headings, pages, folders etc. It has a built-in text-to-speech feature. It also supports additional media sources, such as a USB and an SD card. It has an excellent sound quality for books and music. It has variable speed options that increase/decrease the playback speed. It has an information key for announcing book information, including title, total/elapsed/remaining time, total pages/headings etc. [32].
Telex Scholar **Mfr:** Telex Communication **T.Cost:** $125.33	It is a portable and easy-to-use media player. It has primary controls for volume, variable speed, play/stop, rewind, fast forward, and undo/redo. It has secondary controls for go to, bookmark, set, and page. It is compatible with most CDs. It can automatically detect which media type is in play and provide quick access to specific page numbers and chapters [33].
Victor Reader Handheld Media Player **Mfr:** Humanware **Model** **T. Cost** **Victor Reader Stream** $475 **Victor Reader Trek** $899	It is a handheld audio player that features a phone-like touchpad. It enables VI persons to listen to audiobooks, newspapers, web radio, music, and other online resources. It is simple to use; it packs all media into place and gives 15 hours of battery life, leaving more time to enjoy the content. It is a built-in mono Omni-directional microphone and supports most book formats such as DAISY, NISO, NIMAS, etc. It can easily connect to Wi-Fi, USB or computer and has an SD card slot supports [34].
Plextalk **Mfr:** Shinano Kenshi Co **Model** **T.Cost** **Plextalk Linio** $399.95 **Plextalk PTN2** $375	It is a portable and hands-free digital talking book player and recorder designed for visually impaired users and people with dyslexia. It complies with the DAISY standard and also supports a variety of media. It also supports text-based book playback by synthetic voices. It is powered by a sleep timer function [35].

74 SCANNING AND READING DEVICE

A scanning and reading device is an electronic text-to-speech (TTS) system that can photograph printed material such as books, research journals, magazines, newspapers, etc. and start reading it aloud for VI users. For low-vision users, it can magnify & enhance reading material in various viewing modes. It can quickly convert printed books into digital format and save the documents into PDF, MS Word, MP3, etc., formats.

Figure 6: Scanning and Reading Device

Table 5: Scanning and Reading Device

Name of Device	Features
Divya Nayan **Mfr: CSIR-Central Scientific Instruments Organisation** **T.Cost: 10000 (approx.)**	It is a portable reading machine that can scan a printed document and convert it into speech. It helps VIPs in reading printed documents, e-books, or recorded speeches. It uses Optical Character Recognition (OCR) technique for scanning printed documents and converting it into audio files. It is stand-alone, completely wireless, and IoT-enabled. It has support for speaking Hindi and English and is further compatible with other Indian languages such as Bengali, Kannada, Malayalam, Marathi, Punjabi, Tamil, Telugu, etc. It has an internal storage memory of 8 GB and external memory of 32 GB. It is powered by a 2600 mAh rechargeable battery that scans can and reads up to 60 A4 pages [37].
Kibo XS **Mfr: Trestle Labs** **T.Cost: 49350**	It is a multi-lingual scanning and reading device. It can scan printed or handwritten documents and convert them into digital formats such as .doc, .docx, etc., that can be saved on a computer/ laptop or Kibo Cloud for access across multiple devices. It helps VI users to listen to the scanned content across 60 global languages, including 13 Indian Languages. It can also translate documents into 100+ languages and read them out with the help of the Kibo Web Application. It can easily connect with any Computer/laptop, or smartphone for saving/copying/sharing content. It is compatible with any screen-reading software [38].
Lex **Mfr: VisionAid International** **T.Cost: 55000**	It is a portable scanning and reading device that provides instant access to print material or any physical document. It captures the image of the printed page and, after a few seconds, starts reading it aloud along with the chosen visualisation, text size, colour and formatting. It has a fast multi-page capture option that allows users to capture up to 20 pages per minute and save them on the computer. It is powered by a high-resolution camera that enables it to capture deep into the spines of books and read almost any surface [39].
SARA CE **Mfr: Freedom Scientific** **T.Cost: $2395**	It enables users to convert printed text into spoken text without assistance. It uses OCR technology to scan printed documents and read the contents with clear, crisp, and human-synthesised speech. It is powered with manual & automatic scanning modes. It supports a USB device or external hard drive to save and retrieve reading material. It also allows users to read DAISY (Digital Accessible Information System) format books. For low-vision users, it has brightly-coloured tactile keys and an audible menu. Users can add a monitor to tailor the appearance of text on the screen. It also has built-in Braille support [40]
Readit Air **Mfr: VisionAid International** **T.Cost: $1495**	It enables VI persons to read documents and save them on the computer once captured. For reading any printed material, place the documents under the camera and press Enter key on the keyboard; the device captures the image and starts reading the text aloud a second later. It also allows low-vision users to choose text size, colour and formatting for incredible reading. It can capture 30 pages per minute and enable to capture and save of entire textbooks within a few minutes. Users can import any document, such as PDF, MS Word, Email, etc. & read it directly. It also allows users to export documents to formats of Word, txt, RTF, MP3, etc. It is powered by the latest camera and recognition technology for automatic language detection and switching [41].
PEARL **Mfr: Freedom Scientific** **T.Cost: $310**	It can take a snap of printed material and start reading aloud within 5 seconds in a clear Indian voice. It provides Hi-speed conversion of books into digital format. It can scan 20 pages per minute and is capable of converting scanned files into MP3 format. It can also read 18 foreign languages and have the ability to export documents to Microsoft Word format or Notepad [42]
ReadEasy Evolve **Mfr: VisionAid International** **T.Cost: $2495**	It is a stand-alone reading device that can read printed materials such as books, newspapers, magazines, bank statements, food packaging, medicines, etc. It has two USB 3.0, one HDMI and a display port for input and output connections. It can capture multiple-page documents quickly so they can be read without interruption. It has a PowerRead function to listen and navigate the currently captured pages while adding additional pages and unique navigation control to skip word-by-word to rewind/fast-forward quickly. It can save, load, and import documents in PDF, image, and text format and export them in PDF, Word, image, and MP3 formats. It can bookmark the documents to return to a particular section quickly. For low vision users, it can display the documents in large print on any screen, adjust the size, and enhance them as required [43]

75 MAGNIFYING DEVICE

The magnifying device is used for the magnification and zooming of printed resources. It comes with a lens or combination of lenses to make objects or print documents larger than the actual size. Thus, it enables low-vision persons to read print resources efficiently and helps them keep themselves updated.

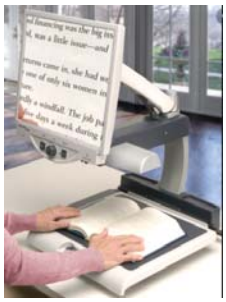


Figure 7: Magnifying Device

The magnifying devices are available in two sizes, i.e. Portable Magnifiers and desktop Magnifiers. Portable Magnifiers are designed to fit in hand and magnify the objects and text from 2x to around 20x.

A list of some most used portable magnifying devices is given below:

Table 6: Portable Electronic Magnifiers

Name of Device	Features
RUBY **Mfr:** Freedom Scientific **Model** / **T.Cost** RUBY HD $545 RUBY 7 HD $645 RUBY XL HD $1195	It is a lightweight, portable, and durable battery-operated magnifying device that can magnify documents from 2x to 14x. It has a built-in LED light and can freeze frames with adjustable magnification. It is powered with high-contrast colour viewing modes and has internal memory to store images [44].
Koolertron 5" Digital Magnifier **Mfr:** Koolertron **T.Cost:** $239.99	It is a compact 5 inches LCD screen magnifying device with free frame capabilities. It has an automatic shut-off function to increase its battery life. It is powered by a double camera design that can view far and near. It allows users to freeze the screen at their convenience to improve accuracy in reading [45].
Pebble HD **Mfr:** Enhanced Vision **T.Cost:** $595	This device has an HD camera with a 4.3″ LCD. It has adjustable magnification from 1.25x to 20x and brightness control with the lights on/off feature [46].
ViSee Portable Video Magnifier **Mfr:** ViSee **Model** / **T. Cost** LVM-500 $209.98 LVM-480 $129.98 LVM 300 $79.98	It is a portable, affordable, user-friendly and high-quality video magnifier. It has an LED screen and power with a screen lock feature. It comes in four models, and the screen size choice is available in 3.5", 4.3", 5" and 7" [47].
Lzcat Electronic Magnifier **Mfr:** Lzcat **T.Cost:** $79.99	It is a pocket-sized, lightweight, and portable electronic screen magnifier. It is powered with different zoom options, i.e., 2X/8X/16X/25X, allowing the user to freeze the frame. It has a 3.5" colour LCD screen and a different scheme for text and background [48].

Desktop Magnifiers: Typically, larger, non-portable devices are placed on a table and used to read print documents and objects. They receive information from a camera and display it on a monitor with a magnified view. Some advanced desktop magnifiers come with high-definition monitors that can change colour, contrast, and optical character recognition. Desktop magnifiers are also called CCTV.

Table 7: Desktop Magnifiers

Name of Device	Features
Topaz **Mfr:** Freedom Scientific **Model** **T. Cost** TOPAZ EZ HD $2495 TOPAZ HD $3095 TOPAZ OCR $3895 TOPAZ PHD $2295 TOPAZ Ultra $2995	It provides a clear, crisp image of text on a monitor screen. Its four models are available with 17", 20", 22", and 24" displays. It has a forward-mounted camera of 8.25" above the table, providing ample room for reading and writing. It can magnify the text up to 64X in high-contrast colour. It allows the users to control the brightness at their convenience [49].
Prisma HD **Mfr:** Ash Technologies Ltd **T.Cost:** $1800	This device is a premium solution for a large range of low vision. It is powered with a wide range of magnification levels from 2.5x to 100x. It enables the low vision to read print books, journal articles, newspapers, magazines, etc., in high-definition clarity. It can be easily connected to an HD TV for reading and writing purposes. Its LED illumination and camera height can be adjusted at users' convenience [50].
Reveal 16 Full HD Digital Magnifier **Mfr:** HumanWare **T.Cost:** $3295	This is an adjustable 16" digital magnifier designed to do reading and writing comfortable for long periods. It is powered by a high-quality camera that can magnify up to 1x to 10x in optical and 1x to 45x in digital. Its image quality is incredibly clean and clear. It has four large and contrasting buttons to operate the device efficiently. It can also display a large visual field and distant objects by pointing the camera in the desired direction [51].

76 LARGE PRINT KEYBOARD

The large print keyboard is specially designed and developed for low-vision users who face difficulties with standard-size keyboards due to their vision impairment. It is available in high-contrast keys, either in yellow or white, with a large black letter.

Figure 8: Large Print Keyboard

Table 8: Large Print Keyboard

Name of Device	Features
Adadmei Large Print Keyboard **Mfr:** Adadmei **T.Cost:** □ 2488	It is a high-contrast wired Keyboard. It has large oversized letter characters and commands keys in a bolder font. It offers increased visibility with easy-to-see yellow keycaps and large print black letters. It enables users to give input to the computers conveniently. It also provides a faster response and excellent typing experience. It is compatible with Windows and Mac operating systems [53].
EasyTouch 132 Luminous 4x Large Print Multimedia Desktop Keyboard **Mfr:** Adesso **T.Cost:** □ 3285	It has a large 4x black print on a yellow-coloured key and offers better visibility to low-vision persons. It provides an excellent typing experience and enables. It has an extra row of dedicated hotkeys for accessing the Internet and media commands that allow VIPs to control their media player and browse the Internet with just one key touch. It also has a keypad for doing calculations faster and easier [54].
HDE Large Print Computer Keyboard **Mfr:** HDE **T.Cost:** □ 5200	It is high contrast, with large print black letters and a yellow keycaps keyboard. It has full QWERTY English (US) key keyboard with a numeric keypad for performing accounting operations. It is easy to install with plug-and-play technology. It is compatible with Windows and Mac operating systems [55].
Zienstar-Wireless Large Print Keyboard **Mfr:** Zienstar **T.Cost:** □4115	It is a white keycap and a large print black letters keyboard. It offers increased visibility to those who have trouble seeing ordinary keyboards. It has an ergonomic design and provides a smooth typing experience to low-vision persons. It is compatible with Windows, Mac OSX and macOS [56].

8 BENEFITS OF ASSIIVE TECHNOLOGY (AT)

Traditionally, VI users were limited only to Braille, audio, and large print resources for their academic needs. Consequently, VI users do not receive most of the information in time. Thus, the advent of ATs has opened new avenues of opportunity for VI users to access the latest information resources

from academic libraries independently that were inaccessible before the implementation of ATs facilities. With the help of AT, now VI users can access print and non-print resources independently by using Braille Displays, Screen Magnifiers, Braille Printers, Daisy Players, Scanning and Reading Devices, etc. Therefore, ATs have become a boon for VI users to be self-sufficient in accessing required information promptly at their convenience.

9 CONCLUSION

To conclude, well-planned AT facilities in academic libraries are essential for using library resources and other library services by VI users. Moreover, library staff should be trained in using the available AT devices to improve the functional capacity and enable the VI users to be independent in using library services. This paper has tried to enlist essential AT hardware that is very useful for academic libraries to facilitate and serve VI users in a more promising way. The essential AT hardware requirements for the inclusive library is a minimum of two PCs, one Refreshable Braille Display, one Braille Printer/Embosser, two DAISY Player, one Scanning & Reading device, one Screen Magnifier, and two Large Print Keyboard etc. Most of these devices are affordable, and almost all types of libraries can acquire these devices. Since almost all institutions have some VI students, the libraries of all the institutions should start implementing at least some AT devices and take a step toward becoming inclusive libraries.

REFERENCES

1. WHO. Blindness and vision impairment. 2021. https://www.who.int/en/news-room/fact-sheets/detail/blindness-and-visual-impairment
2. VIGNESH, D., ET AL. (2019). Prevalence of visual impairment and its association with vision-related quality of life among elderly persons in a resettlement colony of Delhi. Journal of Family Medicine and Primary Care, *8*(4), 1432. https://doi.org/10.4103/jfmpc.jfmpc_188_19
3. MOSPI. (2016). *Disabled persons in India: A statistical profile*. http://mospi.nic.in/sites/default/files/publication_reports/Disabled_persons_in_India_2016.pdf
4. CHERIAN, R. (2013). *Making Public Libraries Accessible to People with Disabilities*. https://cis-india.org/accessibility/blog/making-public-libraries-accessible-to-people-with-disabilities
5. ALA. (2006). *Library Services for People with Disabilities Policy*. https://www.ala.org/asgcla/resources/libraryservices
6. AYOUNG, D. ET AL. (2021). Access to library services and facilities by persons with disability: Insights from academic libraries in Ghana:

Journal of Librarianship and Information Science, *53*(1). https://doi.org/10.1177/0961000620917723

7. BHARDWAJ, R. K. (2021). Information system for visually impaired in Indian universities: a user's perspectives. *Information Discovery and Delivery*, *ahead-of-p*(ahead-of-print). https://doi.org/10.1108/IDD-05-2021-0053
8. PILLAI, P. R. (2011). Provision of library and information services for the visually impaired in India: a study [Doctoral thesis, Savitribai Phule Pune University]. In *Savitribai Phule Pune University*. http://shodhganga.inflibnet.ac.in:8080/jspui/handle/10603/155759
9. NAZIM, M., BEG, A., & SARKAR, M. (2021). Access to library facilities and services for users with disabilities: a study of Aligarh Muslim University in India. *Journal of Access Services*, *18*(1), 30–49. https://doi.org/10.1080/15367967.2020.1870120
10. ADETORO, N. (2011). Availability and use of information materials by persons with visual impairment in Nigeria. *Information, Society and Justice Journal*, *4*(2), 5–18.
11. MINISTRY OF LAW AND JUSTICE. (2016). *The Rights of Persons with Disabilities Act*.
12. POTNIS, D., & MALLARY, K. (2021). Proposing an information value chain to improve information services to disabled library patrons using assistive technologies. *Journal of Information Science*. https://doi.org/10.1177/0165551520984719
13. TRIPATHI, M., & SHUKLA, A. (2014). Use of assistive technologies in academic libraries: A survey. *Assistive Technology*, *26*(2), 105–118. https://doi.org/10.1080/10400435.2013.853329
14. SANAMAN, G., & KUMAR, S. (2014). Assistive Technologies for people with disabilities in National Capital Region Libraries of India. *Library Philosophy and Practice*, *2014*(1).
15. KRITIKAL SOLUTIONS. (2019). *DotBook: Refreshable Braille Display*. https://kritikalsolutions.com/products/dotbook/
16. AMERICAN FOUNDATION FOR THE BLIND. (n.d.). *Refreshable Braille Displays*. Retrieved 19 June 2021, from https://www.afb.org/node/16207/refreshable-braille-displays
17. NIPPONTELESOFT. (2020). *Seika V3*. https://enabled.in/wp/braille-displays-seika-v3/
18. HUMANWARE. (n.d.-a). *Brailliant BI 40X Braille Display*. Retrieved 19 June 2021, from https://store.humanware.com/europe/brailliant-bi-40-new-generation.html
19. IIT DELHI. (2017). *TacRead*. https://assistech.iitd.ac.in/rbd.php

20. HIMS INTERNATIONAL CORP. (2015). *Smart Beetle User Manual*. www.himsintl.com
21. HIMS INTERNATIONAL CORP. (2017). Braille EDGE 40. In *hims-inc*. http://www.hims-inc.com/product/braille-edge-40/
22. FREEDOM SCIENTIFIC. (n.d.-a). *Focus 40 Blue - 5th Generation*. Retrieved 19 June 2021, from https://store.freedomscientific.com/products/focus-40-blue-5th-generation
23. SANTARELLI, R. (2019). *Index braille embosser*. https://commons.wikimedia.org/wiki/File:Index_braille_embosser.jpg
24. INDEX BRAILLE. (n.d.). *Everest-D V5*. Retrieved 12 August 2022, from https://www.indexbraille.com/en-us/braille-embossers/everest-d-v5?c=EUR
25. BRAILLO. (n.d.). *Braille Printers*. Retrieved 19 June 2021, from https://braillo.com/braille-printers/
26. INDEX BRAILLE. (n.d.). *Basic-D V5*. Retrieved 19 June 2021, from https://www.indexbraille.com/en-us/braille-embossers/basic-d-v5?c=USD
27. FLORIDA VISION TECHNOLOGY. (n.d.). *Braille Express*. Retrieved 19 June 2021, from https://floridareading.com/shop/ols/products/braille-express
28. HUMANWARE. (n.d.-b). *Gemini Super Braille Embosser*. Retrieved 19 June 2021, from https://store.humanware.com/hus/gemini-super-braille-embosser.html
29. VIEWPLUS. (n.d.). *VP Columbia 2*. Retrieved 20 June 2021, from https://viewplus.com/product/vp-columbia-2/
30. PIXABAY. (n.d.). *Accessibility Gadget Reading*. Retrieved 27 June 2021, from https://pixabay.com/photos/accessibility-gadget-reading-1331640/
31. KARISHMA ENTERPRISES. (n.d.). *Angel India Pocket Talking Daisy Player, Digital Audio Recorder | ID: 19820352397*. Retrieved 10 March 2022, from https://www.indiamart.com/proddetail/angel-india-pocket-talking-daisy-player-19820352397.html
32. HUMANWARE. (n.d.-d). *Victor Reader Talking Book Players*. Retrieved 27 June 2021, from https://store.humanware.com/asia/blindness/victor-reader-talking-book-players/
33. TELEX COMMUNICATION. (n.d.). *Telex Scholar User Manual*. Retrieved 27 June 2021, from https://www.manualsdir.com/manuals/207973/telex-scholar.html

34. HUMANWARE. (n.d.-e). *Victor Reader Trek – talking book player & GPS*. Retrieved 27 June 2021, from https://store.humanware.com/hus/victor-reader-trek-talking-book-player-gps.html

35. PLEXTALK. (n.d.). *PLEXTALK PTN2*. Retrieved 28 June 2021, from http://www.plextalk.com/americas/top/products/ptn2/

36. *VisionAid International Ltd: Products: Digital Capture Reading Systems: Readit Air - Description*. (n.d.). Retrieved 2 April 2022, from http://www.visionaid.com/phpincludes/en/products/readit_air/readit_air_desc.php

37. CSIR-CSIO. (2020). *Portable Reading Machine for Blind*.

38. TRESTLE LABS. (2019). *Kibo XS Brochure*. https://csrbox.org/product/1575636723Kibo XS brochure_02_00.pdf

39. *LEX*. (n.d.). Retrieved 2 April 2022, from https://www.sparshproducts.com/Lex.htm

40. FREEDOM SCIENTIFIC. (n.d.-d). *SARA Scanning & Reading Appliance*. Retrieved 19 March 2022, from https://support.freedomscientific.com/Products/Blindness/SARA

41. *VisionAid International Ltd: Products: Digital Capture Reading Systems: Readit Wand - Description*. (n.d.). Retrieved 2 April 2022, from http://www.visionaid.com/phpincludes/en/products/readit_wand/readit_wand_desc.php

42. FREEDOM SCIENTIFIC. (n.d.-b). *PEARL*. Retrieved 30 March 2022, from https://www.freedomscientific.com/products/lowvision/pearl/

43. VISIONAID INTERNATIONAL LTD. (2019). *ReadEasy Evolve* (Issue C).

44. FREEDOM SCIENTIFIC. (n.d.-c). *RUBY*. Retrieved 20 June 2021, from https://www.freedomscientific.com/products/lowvision/ruby/

45. KOOLERTRON. (n.d.). *Koolertron 5" Digital Magnifier*. Retrieved 20 June 2021, from http://www.koolertron.com/koolertron-5-digital-magnifierportable-electronic-reading-aid-video-magnifier-support-av-output-to-tv-with-4x8x16x24x32x-zoomfreezemultiple-17-kinds-color-moderechargeable-battery-powered-p-816.html

46. ENHANCED VISION. (n.d.). *Pebble HD 4.3 Inch*. Retrieved 20 June 2021, from https://www.enhancedvision.com/low-vision-product-line/pebble-hd-hand-held-portable-electronic-magnifier.html

47. VISEE. (n.d.). *ViSee Portable Handheld Video Magnifiers for Low Vision*. Retrieved 20 June 2021, from http://www.viseetech.com/portable-video-magnifiers.html

48. EVERYDAY SIGHT. (n.d.). *9 Best Portable Electronic Magnifiers, Lzcat Electronic Magnifier*. Retrieved 21 June 2021, from https://www.everydaysight.com/portable-electronic-magnifiers/

49. FREEDOM SCIENTIFIC. (n.d.-e). *TOPAZ Family*. Retrieved 20 June 2021, from https://www.freedomscientific.com/products/lowvision/TopazProductFamily/

50. ASH TECHNOLOGIES LIMITED. (n.d.). *Prisma HD User Manual*. Ash Technologies Limited. Retrieved 21 June 2021, from http://www.osirix-viewer.com/Manual/index.html#ImagesTransfers

51. HUMANWARE. (n.d.-c). *Reveal 16 Full HD digital magnifier*. Retrieved 20 June 2021, from https://store.humanware.com/hus/low-vision-reveal-16.html

52. ERGOGUYS. (n.d.). *Ergoguys EZSee Large Print Keyboard*. Retrieved 10 August 2022, from https://www.amazon.com/Ergoguys-EZSee-Large-Keyboard-Yellow/dp/B00BV8AW80

53. ADADMEI. (n.d.). *Adadmei Large Print Computer Keyboard*. Retrieved 10 August 2022, from https://www.amazon.com/Adadmei-Computer-Oversized-Individuals-Beginners/dp/B09MLW731L

54. ADESSO. (n.d.). *Adesso Luminous 4 X Large Print Multimedia Desktop USB Keyboard*. Retrieved 17 August 2022, from https://www.amazon.in/Adesso-Luminous-Multimedia-Keyboard-AKB-132UY/dp/B00KN2R206

55. HDE. (n.d.). *HDE Large Print Computer Keyboard*. Retrieved 17 August 2022, from https://www.cart2india.com/keyboards/hde-large-print-computer-keyboard-wired-usb-high-contrast-yellow-with-black-oversized-letters-for-visually-impaired-low-vision-individuals/00000000004328354925?g clid=Cj0KCQjwgO 2XBhCaARIs ANrW2X1O AteD3kBPgopGZ6DYwXi7hA1q

56. ZIENSTAR. (n.d.). *Zienstar-Wireless Large Print Keyboard*. Retrieved 17 August 2022, from https://www.getuscart.com/zienstar-wireless-large-print-keyboard-and-mouse-combo-set-with-usb-receiver-for-visually-impaired-low-vision-individuals? gclid =Cj0KCQjwg O2XBhC aARIsANrW2X3Pt2DpU ErjB7pU5wTWj 9rttBuFa1N_ FNRnVn GUIjVCNajL_ fSQ2dEa AqtdEALw_wcB