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Mobile Assistive Technologies for Visually Impaired Users

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ABSTRACT

Mobile phones have become crucial means of communication and information exchange as the number of people using them grows. Users of mobile phones include both sighted and visually impaired individuals.People with Down Syndrome (PDS) and Intellectual Disabilities (PID) can benefit from ICT tools and Assistive Technologies (AT) to boost their self-confidence and independence, improve their skills and competences, and participate in leisure activities. Due to the lack of physical keys and insufficient accessibility features, touchscreen mobile phones are inaccessible to visually impaired people. The research aids in the comprehension of diverse strategies. Speech to Text converters, Text to Speech converters, and other picture recognition algorithms are among these strategies. For establishing novel applications, it is critical to investigate and compare all of the currently accessible applications and approaches.

Keywords: Vision loss, visual impairment, low vision, blind, IT systems, mobile computer devices, mobile technology, mobile assistive technology, handheld assistive technology.

INTRODUCTION

There are currently only a few accessibility applications for mobile phones that provide various functionalities. These applications are in various stages of development; some are freely available in the Google Play Store, while others are still in the works. Six such applications are being investigated.According to the Telecom Regulatory Authority of India (TRAI), there are 1156.87 million mobile phone subscribers in India as of February 2018, with 650.03 million in urban centers and 506.84 million in rural areas. According to TRAI data (February 2018), India's mobile phone tele-density, or the number of mobile phones in use per 100 people living in a given area, has reached 89.12.

A large population of mobile phone users can be divided into two groups. One group consists of abled users, while the other consists of differently abled users with various disabilities. Users with disabilities in vision, hearing, speech, limb, and other areas are classified as differently abled. Users with vision disabilities, also known as visually impaired users, constitute the majority of differently-abled users.

There are two types of visually impaired people: partial visually impaired people and total vision impairments. The partial visually impaired user's visual acuity is less than 6/18, but equal to or better than 3/60, or a corresponding visual field loss to less than 20 ° in the sharp outlook with best possible correction.

According to World Health Organization estimates (2010), there are 285 million visually impaired people in the world, with 39 million total blind and 246 million partially blind. According to estimates, 90 percent of the visually impaired population lives in developing countries.

Because of the growing popularity of mobile phones, they have become the primary means of communication as well as a source of information. Every day, hundreds of thousands of applications are created and uploaded to Google Play for users to download. However, visually impaired users are unable to use all of these applications. In comparison to sighted users, these users have tremendous difficulty using touchscreen mobile phones.

These users were forced to adapt to the error-prone strategies for using mobile phones or seek out alternatives. Mobile phones are inaccessible due to interaction techniques that require the user to visually locate objects on the screen. Assistive technologies can help with this issue. Assistive technologies make it possible for visually impaired people to use mobile phones.

The accessibility feature, which is the fundamental assistive technology, was introduced in Android version 1.6.

Following that, accessibility has steadily improved in subsequent versions. Mobile phones based on Android provide a self-voice interface on which programmers developers can build their own applications. However, although there currently few assistive technologies, applications, or features available. These features are still in the works and will be improved in the future to make them more accessible. As a result, designing assistive technologies or an effective interaction technique to make mobile phones accessible to visually impaired users is critical.

Technology

There are reportedly only a few accessibility applications for mobile phones that provide various functionalities. These applications are in various stages of development; some are freely available in the Google Play Store, while others are still in the works. Three such applications are being investigated.

Intelligent Eye

Awad et al. had developed a programme called 'Intelligent Eye.' This application provides visually impaired users with multiple features in a single application. Light detection, color detection, object recognition, and banknote recognition are among the features available. Light detection employs an embedded light sensor to determine the intensity and nature of light using different pitched sounds and speech, respectively.Color detection uses the primary camera to capture the surrounding area and tells the color of the area that the user touches on the screen. The primary camera's captured objects are identified using object recognition. Similarly, banknote recognition recognizes the banknote captured by the primary camera. The user receives all output in the form of voice and speech. Figure 1 depicts Intelligent Eye's home screen.

iCue

Raval et al. presented the application ‘iCue.' This app assists visually impaired readers in understanding Indian paper currency or coins. The application's processing is divided into three major parts. Image Capture, Image Identification, and Text-to-Speech Conversion are the three components. In Image Capture, a visually impaired user uses a mobile phone camera to capture an image of a currency note or coin. This image is recalibrated by segmenting it and removing the captured background. Image Identification employs a combination of image processing techniques such as histogram, vector quantization, and feature extraction to detect the currency note or coin. The capable of detecting note or coin value is passed on to the next section, Text-to-Speech Conversion. This section uses speech to communicate the currency value to the visually impaired user.

Currency Detector

Automatic license plate recognition

Jogekar et al. formulated a programme that can capture an image of a vehicle's license plate and detect the number. The image of the vehicle license plate is captured with a mobile phone camera. Image normalization reduces the image size to 300*300. After that, the resized image is converted to grayscale. Various techniques such as Gaussian, Median, and Kalman are used to lure the grayscale image. Image blurring reduced the amount of noise in the image. This image is fed into the OCR module. The characters on the license plate are detected from the image in this module, as is the exact vehicle number.

Based on each of these comparisons, the following remarks are made:

- Intelligent Eye and iCue are extremely beneficial to visually impaired users during cash transactions. These applications, however, cannot verify the currency's authenticity.
- Automatic license plate recognition can assist visually impaired users in locating the correct vehicle. However, the vehicle must be stationary in order to obtain a high-quality image.

Method Of Literature Research

It identified pertinent articles on mobile assistive technology for the visually impaired using a multi-staged, systematic approach to our literature search. During the first stage, a Scopus search (covering databases including PubMed and Web of Science as well as publishers including Elsevier and Springer) for the period up until

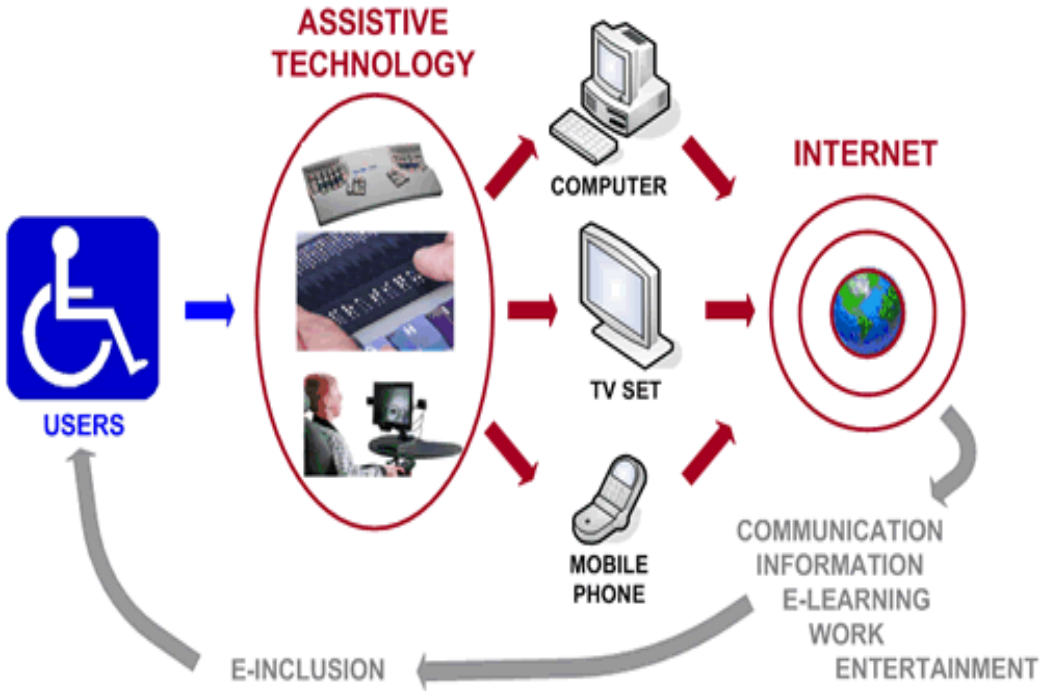
December 2011 was carried out using various combinations of the following search terms: vision loss, visual impairment, low vision, blind, assistive technology, IT systems, mobile computer devices.

Mobile phones have become an important means of communication and information exchange as the number of people using them increases. Mobile phone users include both visually impaired and visually impaired. People with Down Syndrome (PDS) and Intellectual Disability (PID) can benefit from ICT tools and assistive technology (AT) to increase self-confidence and independence, improve their skills and abilities, and participate in leisure activities.

Touch screen mobile phones are not accessible to the visually impaired due to lack of physical keys and lack of accessibility features. Research helps you understand different strategies. Speech Synthesis Converter Text-to-speech converters and other image recognition algorithms are one such strategy. To install a new application, it is important to research and compare all currently available applications and approaches.

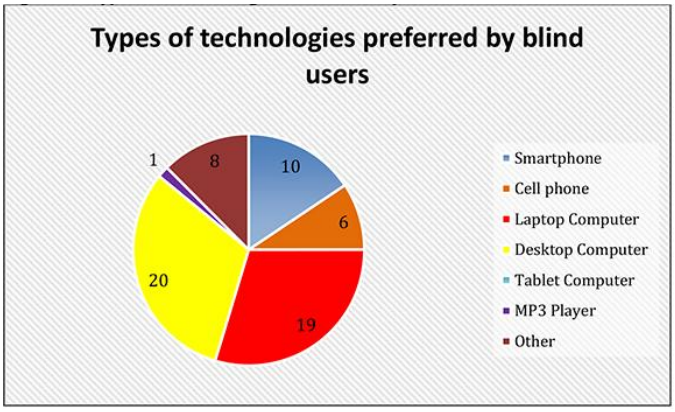
Assistive Technology

Assistive Technology for DifferentlyAbled



Applications for Differently Abled

Types of Technologies used by blind users



CONCLUSION

Accessible built-in features for visual impairment and blind

Smartphones have built-in accessibility features that help all users, regardless of disabilities or functional limitations. These accessible features allow people with disabilities to interact with the content on smart phones. A considerable variety of built-in accessibility features have been developed expressly for those who are blind or have visual impairments. Table 1 highlights a few cases.

Table I: Accessible built-in features of smartphones

Features	***Operating system***	***Operating mode***	***Descriptions***
Voice assistant (Google assistant, Siri)	iOS/Android	Audio based	Ask it a question. Tell it to do things
TalkBack	Android	Audio based	Screen reader

Voiceover	iOS	Audio based	Screen reader
Text to Speech/Voice recognition	iOS/Android	Audio based	Read aloud
Select to speak	iOS/Android	Audio based	Select to speak, Speak selection
Zoom magnification/Font size	iOS/Android	Visual based	Zoom in the display
Contrast	iOS/Android	Visual based	Differences between an object and its background.
Invert colors	iOS	Visual based	White becomes black, black becomes white, orange becomes blue.
Voice Inputs Keyboards	iOS/Android	Audio based	Typing through voice command

Third party accessible applications for visual impairment and blind

If human-digital technology-interaction, i.e. the interface, depends on the vision, people with visually impaired access to information of all kinds on the smartphone face enormous limits. With ongoing advancements and sophistication in mobile technology, the smartphone can be operated efficiently with an eyes-free interface. These accessible applications rely on audio and tactile/haptic interaction, which eliminates the need for visual interaction. There are numerous "apps" available for people with visual disabilities. Table 2 contains a few examples, each with a brief description. Figure 6 depicts a few examples of easily accessible apps.

Table II: Some accessible applications for visual impairment of smartphones

Apps	***Operating system***	***Operating mode***	***Descriptions***
Kibo	Android	Audio based	Image reading, (pdf, e-book, doc, reader Hindi & English both
Be My Eyes	Android, iOS	Audio based	Help by Sighted person (volunteer) through video calling
Supersense	Android, iOS	Audio based	Information about surrounding, Artificial intelligence (AI)
Visor	Android, iOS	Video based	Magnifier (Near objects)
Binoculars	Android, iOS	Video based	Distance viewing (Super zoom camera)
Mani	Android, iOS	Audio based	Mobile Aided Note Identifier
BlindSquare	iOS	Audio based	Navigation, search places, etc.
Khabri	Android	Audio based	Audio news, current affair, job, horoscope, stories, and promotional podcasts Hindi, etc.
Phonepe or Google Pay	Android, iOS	Audio based	Easy and reliable way to make hassle-free payments online, E-Transaction
AccessNote	iOS	Audio based	Note taking
KNFB Reader	Android, iOS	Audio based	Its text-to-speech, text-to-Braille, and text highlighting tools make it valuable for blind
Blind Bargains	Android, iOS	Audio based	It brings you the latest sales, deals, and news on computers, screen readers, notetakers, Braille printers, hard drives, accessible cell phones, memory cards, talking products, household items, and much more
Seeing Eye GPS	iOS	Audio based	The Seeing Eye GPS, is a fully accessible turn-by-turn GPS iPhone app with all the normal navigation
Bard Mobile	Android, iOS	Audio based	It allows you to download and read audio books from the National Library Service (NLS) for the Blind, but needs to register in NLS

Audible	Android, iOS	Audio based	It provides a lot of audio books for people with visual impairment and blind

Table IV: Activity base sensing and coverage of activities

Type of Sensing	Activity	Example	Coverage
Identification	Object Identification, what are the object primary identifier	What is this? A chair, a tablet? Identifying Cold drinks cane Identifying Medicine and Pills Playing CD of your Choice	No Context With Context Description
Description	Visualizing description of some visual or physical property of an object	Own Appearance Knowing Colors Cloths and Dressing, Fashion Lighting in the room Device-Specific attributes	A similar attribute of an object of interest
Reading and understanding	Access to text	Reading the information in a book Reading email and replying Reading digital display and singe Reading currency classification	Accessing text extracting from objects

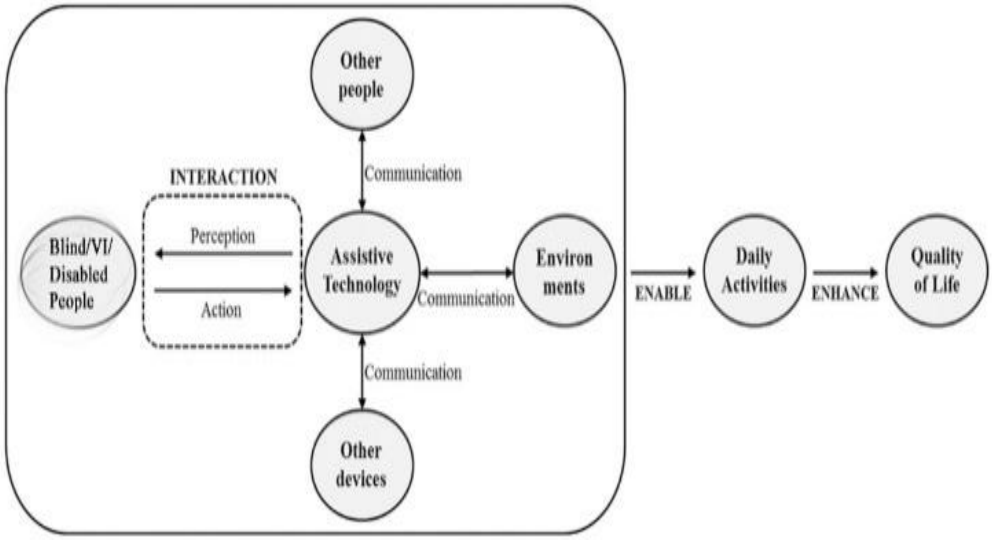


Figure 1:Diagram of Assistive technology working model for People with Visual Impairment and Disabled People

Figure 1 illustrates the overall flow of the working model of assistive technology for people with visual impairment or disabled people. People with visual impairment interact with these devices, software and the environment through assistive technology. This allows people with visually impairments in performing their daily life activities and experience an enhanced quality of life.

Table V: Activities of blind people using Smartphones

Activity	Challenge	Limitation
Dialing/ Making Call	Finding/Locating Keys on Dialer Wrong Touch/invalid touch Dialing/Ending Call	Dimensional Trade-off Task Adequacy Behavior equivalence
Sending/Receiving Message	Finding/Locating Keys on Keyboards Backspace Sentence Repetition and correction of Sentence	Dimensional Trade-off Task Adequacy Behavior equivalence

Sending/Receiving Emails	Security and Identify Management Finding Read/unread emails Smart labeling Reply/forwarding/attachment Maintaining the state/status of the screen Contact management Spamming Degree of importance	Dimensional Trade-off Task Adequacy Behavior equivalence Semantic loss
Internet surfing	Remembering URL Favorites/bookmarks Finding relevant contents (table data, non-table data, important terms) Navigation Breadcrumbs Skipping irrelevant contents (ads, banners) Form filling/interacting forms	Semantic loss Behavior equivalence
Socializing	Security and Privacy Interacting with peers and family Sharing audio resources Identification of non-text-based media (pictures, videos)	Semantic loss Behavior equivalence Task Adequacy
Reading Text	Locating/identifying text of interest Highlighting Relevant Contents Reading preferences Repeating a particular sentence/content Understanding pictorial representation	Semantic loss Behavior equivalence Dimensional Trade-of
Finding Locations	Finding Location around you Mobility aids Current Context Lack of landmarks Inconsistent usage of Tags in the real world	Semantic loss Behavior equivalence Dimensional Trade-of
Shopping	Inconsistent Tags Identification of Products Shopping list Paying products and delivery	Semantic loss Behavior equivalence Task Adequacy

Use among visually impaired and blindness

Smartphones, as well as their accessibility features and applications, are being utilized for a variety of daily chores that would previously have required the use of traditional assistive equipment, such as magnifiers. To have customized functionality, the operating system can download a third-party accessible application. These accessible apps is being used for sighted assistance, communications, emailing, reading e-Books and writing (Access Note, Be My Eyes, KNFB Reader, TalkBack, Braille Touch), news reading and listening (AccessWorld, Blind Bargains), entertainment, calendar functionality, currency identification, GPS navigation (Mani app, BlindSquare, Seeing Eye GPS), social networking, and more.

According to an exploratory study on smartphone use among adults with visual impairment, more than 90% of respondents used their phone for things like making calls, sending and receiving messages, browsing the web, and reading emails. 70%–80% of them utilized their smartphones for calendar functions, music listening, social media, and networking; 60 to 70 percent of them used for reminders and to take photos for reading with Optical Character Recognition. This study also shows that 80 percent of partic- ipants used a smartphone for outdoor GPS navigation. According to a 2014 online poll performed in a developed country, 81 percent of respondents with a visual impairment used smartphone apps for a variety of ordinary tasks.

We strongly support the potential of smartphone-based technologies to be greatly enriched if IT and healthcare professionals work together to adopt a true design philosophy aimed at developing next-generation interfaces to improve the quality of life of the visually impaired. and blind.

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