Journal of ICSAR
ISSN (print): 2548-8619; ISSN (online): 2548-8600
Volume 7 Number 1; DOI: http://dx.doi.org/10.17977/um005v7i12023p37

Literature Review: Orientation and Mobility Assistive Technology for Students with Visual Impairment

Ida Alfa Nerri[1,*], Endang Purbaningrum[1], Asri Wijiastuti[1], Sri Joeda Andajani[1], Md Abu Bakor Siddik[2]

[1] Department of Special Education, Universitas Negeri Surabaya, Surabaya, Indonesia
[2] Freelance Researcher, Japan

*Corresponding Author e-mail: idaalfanerri@gmail.com

Abstract: The development of increasingly sophisticated technology is accompanied by the discovery of new assistive devices that should be accessible to all people, including the blind in order to maintain or improve functions so as to improve welfare. This study uses a literature review method with descriptive analysis by analyzing 20 articles. The purpose of this research is to examine more related to assistive technology for the blind in navigating indoors and outdoors including buildings and the accessibility of public services. The literature search was carried out through an electronic search for publications from ERIC, Researchgate, Spingerlink, Sage, Science Direct, Google Scholar and IEEE Xplore. The results of the study describe the use of various assistive technologies for the visually impaired related to navigation in spaces or buildings and even the wider environment as well as public services that are commonly accessed by the public. Furthermore, it is related to the existence of a brief description of the assistive technology developed and the benefits of the results of the development for users.

Keywords: assistive technology, mobility orientation, blind

INTRODUCTION

The development of human life in this era cannot be separated from one word, namely "technology". Technology is a means or system that can provide convenience and comfort for all humans. Technological developments cover various fields in human life so as to produce various technologies so that they can be used as tools to achieve human goals in order to participate in education, work, and family and community life. Several kinds of technology are often used today, such as computers, laptops, smartphones, and other electronic machines. Furthermore, assistive technology or assistive technology refers to assistive products and related systems and services developed for people to maintain or improve functioning so as to improve well-being. Among the people who generally need assistive technology are the elderly, the disabled and people living with chronic conditions. Further for persons with disabilities, assistive technology includes any item, equipment or product that is used to enhance and maintain functional abilities. Assistive technologies including low vision devices, hearing aids, and augmentative and alternative communication systems, walking frames, wheelchairs and prosthetic limbs, Further for persons with disabilities, assistive technology includes any item, equipment or product that is used to enhance and maintain functional abilities. Assistive technologies including low vision devices, hearing aids, and augmentative and alternative communication systems, walking frames, wheelchairs and prosthetic limbs, Further for persons with disabilities, assistive technology includes any item, equipment or product that is used to enhance and maintain functional abilities. Assistive technologies including low vision devices, hearing aids, and augmentative and alternative communication systems, walking frames, wheelchairs and prosthetic limbs (Tangcharoensathien V,

Witthayapipopsakul W, Viriyathorn S, 2018). Without assistive technology, persons with disabilities and the elderly and others in need are often discriminated against, isolated, and confined to poverty, and the burden of morbidity and disability increases (WHO, 2018) .

Based on statistical data submitted by the WHO, it shows that there are about 253 million people with visual impairments, as well as 36 million total blindness, and 217 million have average to severe visual impairments (WHO, 2017). The various backgrounds of the blind persons seem to be to responsible. Some people have congenital blindness, which has existed in them since birth. Then, the others occurred when they were still teenagers or even adults. These events were triggered by a variety of circumstances, including illness, accidents, reading habits, and blindness, which is an underlying cause (Jendriadi, et al., 2018). Vision is a very important system for humans to understand the outside world because 85% of information can be obtained through the sense of sight (Suharmini, 2009), where this is very influential on cognitive and affects the progress of spatial perception (Gori, M, et al, 2016). A visual impairment is an abnormality in the vision that makes it necessary to employ other senses to comprehend an item (Pahlawaty & Aprilia, 2022). In addition, the impact of vision loss may be implied by limitations in independent mobility (Lamoureux et al., 2004). Orientation and mobility abilities is the ability of individuals to move from one place to the destination safely (Yosfan Azwadi, 2004; Rahayu & Sunardi, 2018). Furthermore, in order to get to their destination safely they need tools. Fulfillment of assistive devices for persons with disabilities in Indonesia in accordance with Law no. 16 of 2008 CHAPTER 3 Article 5 has rights including the right to accessibility, public services, and to live independently and be involved in the community. The number of blind people is increasing, assistive technology / assistive devices have become a big demand over the last few years (Dakopoulus, D and NG Bourbakis, 2009). Orientation and mobility aids are currently common and often used such as guide dogs, watchdogs / companions, and canes, of which canes are the most popular and frequently used tools for blind people (Batman, 2018).

Likewise in Indonesia, sticks are the main choice used to assist orientation and mobility, according to Mukarami in Milati (2019), sticks have functions including: (1) can reduce the assistance of alert people, (2) as a tool used to detect direct obstacles such as detecting stairs and determining a place/location, (3) for protection for the blind, so that skills in using a cane can make the blind person able to move from one place to the destination independently, fluently, and more easily understand the environment. However, the use of sticks also has drawbacks, namely the information provided regarding the position of obstacles or obstacles is still very limited. Based on the findings from various disciplines, various devices have been developed that help to complete activities in daily life. Not only that, many assistive technology findings have been developed for the blind to access public services such as terminals, subways, shopping areas and others. This is in accordance with the Regulation of the Minister of Public Works Number: 30 / PRT / M / 2006 related to the Technical Guidelines for Facilities and Accessibility in Buildings and the Environment which contains the provision of facilities and accessibility related to infrastructure in buildings and their environment. Based on the existing regulations, it can be interpreted that although the orientation and mobility abilities of the blind are good, they still need instructions in the form of clues or instructions in the form of visual, auditory, kinesthetic, tactile stimuli, aroma, temperature, which serve to facilitate the user (Raharja, 2010). Therefore, based on the background that has been raised regarding assistive devices for the blind in orientation and mobility, after studying and analyzing in depth this article aims to examine more related to assistive technology for the blind in navigating indoors and outdoors including buildings. and accessibility of public services sourced from relevant articles between 2011 and 2022.

METHOD

A literature review research design that examines and critically examines existing knowledge, ideas, or findings in academically oriented literature, and formulates theoretical and methodological contributions covering certain topics (Cooper, 2010). According to Creswell (2008) literature review is an activity to summarize articles in journals and/or proceedings, books, and other documents that are relevant to the chosen topic. Literature review includes research results published from 2011 to 2021. The process in writing literature review articles according to Ramdhani, Amin & Ramdhani. (2014) revealed that there are four stages in making a literature review, namely (1) choosing a topic or theme to be reviewed, (2) finding and selecting suitable/relevant articles according to the topic of discussion, (3) carry out analysis and synthesis of literature and (4) organize review writing. So from this theory, in writing this article in the first stage, namely searching for journals in the database through electronic search for ERIC publications, Resnearch Gate, Spinger Link, Sage, Science Direct, Google, Google Scholar. The search uses the keywords blind, assistive technology, orientation and mobility in English and Indonesian. The search results are 35 articles that can be accessed in full text in pdf and MSword formats. The second stage selects articles according to specific criteria according to the criteria, namely (1) types of assistive technology for orientation and mobility inside and outside the environment, (2) assistive technology to access existing public facilities such as public transportation and shopping centers.Stage 3 synthesis of the 20 selected articles were grouped into three categories, namely (1) assistive technology for the blind to orient and navigate indoors, (2) assistive technology for the blind to navigate outdoors or buildings, (3) assistive technology for blind people to access public services (public transportation and shopping centers). The next stage is descriptive analysis by doingregular parsing of the data that has been obtained, then given an understanding and explanation so that it can be understood. Data collection contains criteria according to the quality of the articles and their relevance to topics related to assistive technology for orientation and mobility for the blind. So from the discovery of the articleas many as 27 articles were used as references for writing articles as many as 20 articles and 7 articles were not used.

RESULT AND DISCUSSION

Result(s)

Table 1. Finding of Literature Review

Writer	Brief Description	Function	Participants
Abreu, David., et al. (2020)	The smartphone app is used in conjunction with a white stick that has two senders connected to the smartphone via bluetooth	Road detection	25 blind people
Sánchez, Jaime. (2012)	Development of video game audio and haptic interfaces that allow the stimulation of orientation and mobility skills in the visually impaired through the use of a virtual environment	Virtual navigation to real navigation	10 blind students
Besden, Cheryl. (2019)	Tactile map with bus guide book and use of PIAF (Pictures in a Flash) tactile drawings	Navigation and tactile	2 blind students
Sánchez, Jaime and Claudio Oyarzún. (2011)	Development of handheld applications that allow users to plan trips and provide contextual information during trips with voice output.	Direction and distance identification, position marking	4 blind people
Long, Shelby K., et al. (2016)	Portable maps can be accessed by users anywhere and provide feedback through hearing and touch.	Outdoor navigation and object detection	6 blind people
Maidenbaum, Shachar, et al. (2014)	implement a simple algorithm for blindness using a virtual wand, modeled on the electronic travel aid "EyeCane"	Virtual navigation (indoor)	23 (20 myopic and 3 congenital blind)

Karen, Duarte, et al. (2014)	Smartphone support systems and applications to help the visually impaired in shopping centers	Public building navigation (shopping mall)	n/a (prototype)
López, Diego, et al. (2011)	BlindShopping is a mobile based on RFID and QR codes to help the visually impaired shop at supermarkets	Public building navigation (shopping mall)	n/a (prototype)
Yi , Chucai, et al. (2013)	Object discovery prototype system with camera-based networking and match-based recognition	Navigation and object identification	n/a (prototype)
Jubril, Abimbola M. and Segun J Samuel. (2021)	A multisensor fusion detection system that combines three techniques, namely: laser light source, camera and ultrasonic sensor.	Obstacle detection and warning system	20 blind volunteers
Liimatainen, Jukka, et al. (2012)	Blind user-centered application through the use of sensor technology	Navigation outside the neighborhood	11 blind students
Milati, Nur, et al. (2019)	The tool consists of four parts in the form of an ultrasonic sensor, a microcontroller (arduino), a stick, and earphones and a battery as a supplier of electrical energy.	Navigation and prevent rain noise	6 blind students
Branig, Meinhardt and Christin Engel. (2019)	SmartCane is a combination of an ordinary stick with a robot ball	Navigation scenario	n/a (prototype)
Constantinos, P., et al. (2015)	Maps via multimodal applications using the power of haptic feedback devices	Place orientation and navigation	11 blind adults
Koukourikos, P. & Papadopoulos, K. (2015)	Maps with multimodal application and studied with low cost haptic device, Novint Falcon	Space form concept orientation	10 blind adults
Apprey, M., W., et al. (2022)	Blind Navigation System using Arduino and 1sheeld	Navigation and communication in the neighborhood	5 volunteers (blindfolded)
Velázquez, R., et al. (2018)	a new navigation system that combines GPS and tactile-foot stimulation to represent information	Navigation and tactile stimulation of the feet	20 students
Paiva, S., et al. (2021)	navigation application system that uses the dijkstra algorithm in its implementation	Navigation routes, taxi points, parking lots and city landmarks	6 students
Chaudary, B., et al. (2017)	a tele-guidance navigation system for VIPs assisted by verbal instructions of remote caregivers receiving video from cameras brought by VIPs.	Navigation in the neighborhood	19 visually impaired
Fiannaca, A., et al. (2014)	HEADLOCK is designed for optical head mounted displays, such as Google Glass.	Navigation in the neighborhood	8 blind people

Discussion(s)

Assistive technology for orientation and navigation in the room

The development of video games with audio and haptic interfaces with stimulation of orientation and mobility skills in visually impaired persons through the use of virtual environments in school-age blind students shows that playing and practicing with AHM improves the development of O&M skills in blind learners (Sánchez & Oyarzún, 2011). Development of object discovery prototype system with camera-based network and match-based recognition using SURF and SIFT point of interest detectors and descriptors (Yi et al., 2013). Development of the EyeCane assistive device for navigating down corridors, virtual-EyeCane identical stimuli to those rendered from EyeCane in the real world has the potential to increase the efficiency of navigation through new virtual-learned real-world environments (Maidenbaum et all., 2013). The development of an audio-tactile map will support the development of a cognitive route which in the trial results significantly better performance on

spatial tasks (Koukourikos & Papadopoulos, 2015). Development of three-dimensional (3D) tactile maps for orientation and mobility (O&M) training provided to visually impaired persons improves comprehension, memory, and walking along unfamiliar routes in comparison to the effect of verbal explanation alone (Papadopoulos et al., 2015).The development of HEADLOCK is designed for optical head mounted displays, such as Google Glass where the qualitative results show the design of wearable assistive devices for visually impaired users (Fiannaca et al., 2014).

Assistive technology for navigating outdoors/buildings

The development of EBAT technology with detection and avoidance of obstacles located in the path to be traversed demonstrated a significant reduction in the number of accidental contacts in the travel path and resulted in clear benefits by reducing participants' insecurities,(Abreu et al., 2020). A portable, anywhere-accessible map application to mark obstacles in the outdoor environment such as fallen trees, mud, possible wildlife, and holes (Long et al., 2016). The development of an electronic multisensory tool that detects holes or obstacles combined with ultrasonic sensing, so that the presence of obstacles can be distinguished from holes, where the test results are users can receive and use the device properly (Jubril & Samuel, 2021). The development of an application prototype implemented for the Nokia 5800 touch screen phone with the Symbian series 60 operating system provides an effective approach to introduce students to pathfinding in the school environment (Liimatainen et al., 2012). The development of the INSTIBLIND tool to reduce rain noise which consists of four parts in the form of ultrasonic sensors, microcontrollers (arduino), sticks, and earphones and batteries as suppliers of electrical energy, the category is very useful for the visually impaired (Milati, 2019). The development of SmartCane by installing a robotic ball at the end of the stick and how to calibrate and control it automatically which the results of prototype trials can help the visually impaired navigate (Branig &Engel, 2019). The development of the Blind Navigation System using Arduino and 1sheeld is a system that aims to improve the blind people's access to the environment, especially in Ghana where the trial results obtained from the final test ensure the safety and speed of mobility (APrey et al., 2022). The development of a new wearable navigation system for blind walkers by combining a global positioning system (GPS) for the user's outdoor localization and tactile-foot stimulation and experimental results show users are able to recognize with high accuracy the tactile feedback given to their feet (Velázquez etal., 2018). Development of a prototype mobile application jointly developed with the City Hall of Viana do Castelo, a city in northern Portugal, targeting people with permanent or temporary limited mobility and intending to show them information about taxi points, parking lots and reference points in the city (Paiva, 2020). Development of a tele-guidance navigation system for VIPs assisted by verbal instructions of remote caregivers receiving video from cameras brought by VIP (Chaudary et al., 2017).

Assistive technology forAccessing public services

The ability to access public services is something that the visually impaired can also do independently without relying on an alert companion. Through the development of tactile maps and braille bus guidebooks where flexible lesson plans for teaching bus travel will add to the experience for students that will be more likely to apply the O&M skills they learn at home or at school with the goals already achieved (Besden, 2019). Another development that is still related to public transportation access is the AudioTransantiago application to adjust and move on a trip that is carried out using the bus public transportation system in Santiago de Chile where the test results of participants show a high level of skill in using the buttons on a pocket PC and audio is received well by users (Sánchez & Oyarzún, 2011).The development of other

assistive technology in the form of access to other public services that can be taken is shopping centers. The environment setting is equipped with an adequate RFID sensor with a Bluetooth connection to the user's smartphone, the system can find the user and send instructions pointing to the desired destination. Important features that users can access about a store, service or available space(Duarte et al., 2014). Almost the same as other application developments that do not use Bluetooth channels, but this Blindshopping application uses a mobile-based QR code (López-De-Ipiña et al., 2011).

CONCLUSSION

Based on the results of the research review analysis above, it can be concluded that many technologies have been developed following the times. The development of assistive technology for the visually impaired is proven to provide benefits for users, including assisting in daily activities such as orientation indoors, as a guide to navigate indoors and outdoors, to access public facilities such as shopping centers and public transportation. So from these results found 6 articles on the development of assistive technology products that are useful for the blind to orient and navigate indoors, 10 articles on the development of assistive technology products that are useful for the blind to navigate outdoors or buildings, 4 development of assistive technology products for the blind to access public services (transportation and shopping centers). Seeing the development of increasingly sophisticated science and technology, it is very possible for innovations to develop in assistive technology that can help the blind to be oriented and move in the environment independently and safely.

REFERENCES

Abreu, D., Codina, B., Toledo, J., & Suárez, A. (2020). Validation of an eBAT as a mobility aid for blind people. Assistive Technology, 00(00), 1–9. https://doi.org/10.1080/10400435.2020.1743380

Apprey, M. W., Agbevanu, K. T., Gasper, G. K., & Akoi, P. O. (2022). l P re r f. Sensors International, 100181. https://doi.org/10.1016/j.sintl.2022.100181

Batterman, J.M., Martin, V.F., Yeung, D., & Walker, B. N. Connected cane: Tactile button input for controlling gestures of iOS voiceover embedded in a white cane. Assistive Technology, 30(2), 91–99.

Besden, C. (2019). Design of a map and bus guide to teach transferable public transit skills. Journal of Visual Impairment and Blindness, 103(5), 267–270. https://doi.org/10.1177/0145482x0910300504

Branig, M., & Engel, C. (2019). SmartCane. 327–328. https://doi.org/10.1145/3316782.3322742

Chaudary, B., Paajala, I., Keino, E., & Pulli, P. (2017). Tele-guidance based navigation system for the visually impaired and blind persons. Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST, 181 LNICST, 9–16. https://doi.org/10.1007/978-3-319-49655-9_2

Creswell, John W. 2008. Educational Research, planning, conduting, and evaluating qualitative dan quantitative approaches. London: Sage Publictions.

Dakopoulos. G., & Bourbakis,. N. G. (2009). Wearable obstacle avoidance electronic travel aids for blind: A survey. IEEE Transactions on Systems Man & Cybernetics Part 3, 40(1), 25–35.

Duarte, K., Cecílio, J., Sá Silva, J., & Furtado, P. (2014). Information and assisted navigation system for blind people. Proceedings of the International Conference on Sensing Technology, ICST, 2014-January, 470–473.

Fiannaca, A., Apostolopoulous, I., & Folmer, E. (2014). Headlock: A wearable navigation aid that helps blind cane users traverse large open spaces. ASSETS14 - Proceedings of the 16th International ACM SIGACCESS Conference on Computers and Accessibility, 1, 19–26. https://doi.org/10.1145/2661334.2661453

Jendriadi, J., Sukandar, W., & Rossa, R. (2018). Life Skills Education for People with Disabilities at Blind Orphanage “Tuah Sakato” West Sumatra Indonesia. Journal of ICSAR, 2(2), 171-174.

Jubril, A. M., & Samuel, S. J. (2021). A multisensor electronic traveling aid for the visually impaired. Technology and Disability, 33(2), 99–107. https://doi.org/10.3233/TAD-200280

Koukourikos, P., & Papadopoulos, K. (2015). Development of Cognitive Maps by Individuals with Blindness Using a Multisensory Application. Procedia Computer Science, 67(Dsai), 213–222. https://doi.org/10.1016/j.procs.2015.09.265

Liimatainen, J., Häkkinen, M., Nousiainen, T., Kankaanranta, M., & Neittaanmäki, P. (2012). A mobile application concept to encourage independent mobility for blind and visually impaired students. Lecture

Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 7383 LNCS(PART 2), 552–559. https://doi.org/10.1007/978-3-642-31534-3_81

Long, S. K., Karpinsky, N. D., Döner, H., & Still, J. D. (2016). Using a mobile application to help visually impaired individuals explore the outdoors. Advances in Intelligent Systems and Computing, 500, 213–223. https://doi.org/10.1007/978-3-319-41962-6_19

López-De-Ipiña, D., Lorido, T., & López, U. (2011). Indoor navigation and product recognition for blind people assisted shopping. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 6693 LNCS, 33–40. https://doi.org/10.1007/978-3-642-21303-8_5

Maidenbaum, S., Levy-Tzedek, S., Chebat, D. R., & Amedi, A. (2013). Increasing accessibility to the blind of virtual environments, using a virtual mobility aid based on the "EyeCane": Feasibility study. PLoS ONE, 8(8), 1–7. https://doi.org/10.1371/journal.pone.0072555

Milati, N. (2019). Intelegent Stick for Blind (Instisblind) Inovasi Alat Bantu Mobilitas Pencegahan Kebisingan Hujan Untuk Meningkatkan Kemandirian Penyandang Tunanetra. Jurnal Edukasi Elektro, 3(1), 47–53. https://doi.org/10.21831/jee.v3i1.26070

Pahlawaty, N., & Aprilia, I. D. (2022). MiBee Braille Application: An Alternative Accessibility Literacy for Totally Blind Students at Inclusive School. Proceeding of International Conference on Special Education in South East Asia Region, 1(1), 1–12.

Paiva, S. (2020). Technological Trends in Improved Mobility of the Visually Impaired (Issue April).

Papadopoulos, K., Koukourikos, P., Koustriava, E., Misiou, M., Varveris, A., & Elena, V. (2015). Audio-Haptic Map: An Orientation and Mobility Aid for Individuals with Blindness. Procedia Computer Science, 67, 223–230. https://doi.org/10.1016/j.procs.2015.09.266

Rahayu, D., & Sunardi, S. (2018). The Effectiveness of Straight Line Walk Application Used on Straight-Walking Skills for Blind Students. Journal of ICSAR, 2(2), 148-152.

Sánchez, J., & Oyarzún, C. (2011). Mobile audio assistance in bus transportation for the blind. International Journal on Disability and Human Development, 10(4), 365–371. https://doi.org/10.1515/IJDHD.2011.053

Tangcharoensathien V, Witthayapipopsakul W, Viriyathorn S, P. W. (2018). Improving access to assistive technologies: challenges and solutions in low-and middle-income countries. WHO South-East Asia journal of public health. 7(2), 83.

Velázquez, R., Pissaloux, E., Rodrigo, P., Carrasco, M., Giannoccaro, N. I., & Lay-Ekuakille, A. (2018). An outdoor navigation system for blind pedestrians using GPS and tactile-foot feedback. Applied Sciences (Switzerland), 8(4). https://doi.org/10.3390/app8040578

Yi, C., Flores, R. W., Chincha, R., & Tian, Y. (2013). Finding objects for assisting blind people. Network Modeling Analysis in Health Informatics and Bioinformatics, 2(2), 71–79. https://doi.org/10.1007/s13721-013-0026-x