Journal of Innovative Technology Convergence
Vol. 5, No. 1 June 2023, pp. 31-38

A Study on the Development of Interactive Technology for the Convenience of the Visually Impaired

Nayeon Kim *

Abstract: In this paper, as human-computer interface (HCI) technology advances, opportunities are analyzed to provide a better service environment for the visually impaired. The system and user interaction for the visually impaired will become possible through the convergence of technologies that include location-based services, wireless body sensor networks, and smart devices, which can have direct and positive impacts. The system connects to the user's mobility assistance device through a smartphone app and helps the user walk to identify and guide through obstacles. This interactive technology is expected to provide a convenient environment for visually impaired users.

Keywords: HCI technology, Wireless body sensor networks, Wireless networks, Location-based services, Interactive technology

1. Introduction

In the fourth quarter of 2020, the Laser Eye Surgery Hub (LESH) estimated that around 2.2 billion people worldwide live with a vision impairment [1]. They also reported that in 2020, those who have moderate or severe distance vision impairments will reach around 237 million, of whom 55% are women. It is also believed that in the same year, 39 million people are expected to be blind globally, which is expected to increase to 115 million people in 2050. According to the World Health Organization (WHO), in their report on October 2019, at least 2.2 billion people have vision impairment or blindness that may or may not have been addressed [2][3]. Vision impairment and blindness impact the lives of people of all ages, affecting children and most severely in people aged 50 and above. The quality of life of those suffering from visual impairment and blindness decreased resulting in lower productivity, decreased workforce participation, and high rates of depression [2].

Currently, visually impaired people can walk with the help of mobility aids or guide dogs. The number of visually impaired people is steadily increasing, and accordingly, efforts are being made to help the visually impaired people in their daily lives. For safe walking, interaction between the smart mobility assistance system and the user is required. Since it is difficult for visually impaired people to grasp obstacles in unfamiliar places, a recognition system that considers obstacles is needed.

---

* Multimedia Engineering Department, Hannam University, Daejeon, South Korea
Email: ny452019@naver.com

Received [February 24, 2023]; Revised [April 14, 2023]; Accepted [May 22, 2023]

© 2023 The Authors.
This is an open access article licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.
To view a copy of this license, visit http://creativecommons.org/licenses/by-nc/4.0/.

Published by InnoCon Publishing
ISSN 2704-4440

Therefore, in this paper, a better environment for the visually impaired using human-computer interface (HCI) technology and the interaction between HCI technology-based devices and users are described.

The rest of this paper is structured as follows: Section 2 describes the HCI technologies that are currently commercialized for the disabled; Section 3 describes the technology required for wayfinding services for the visually impaired and the development of the interactive technology; and Section 4 discusses the conclusion and future directions.

2. HCI Technologies and Aids Used for the Disabled

This section discusses in detail the HCI technologies and assistive devices for the disabled that were significant in providing a convenient environment for the visually impaired.

2.1 Assistive Devices for the Disabled

Currently, many auxiliary engineering devices designed to help the disabled are being commercialized. Auxiliary engineering devices refer to all devices studied and developed to help the disabled, the elderly, *etc*. lead their daily lives and professional lives well. This includes devices employing electronic engineering technology, including software and hardware, and instrument devices that improve physical functions. These tools are being upgraded with continuous technological development.

Figure 1. The Braille Technology

Among these assistive technologies is Braille, which allows blind or visually impaired people to read, write, or manipulate braille electronically [4]. This technology allows visually impaired users to do common tasks such as writing, browsing the Internet, typing in Braille and printing in text, engaging in chat, downloading files and music, using electronic mail, burning music, and reading documents.

It also assists visually impaired students to do their homework and school chores as their classmates and helps professionals perform their daily tasks in offices [5]. The Braille technology is comprised of assistive devices, including a braille keyboard to input text and an output device where the blind or the deaf may not be able to see or hear the contents, but they can feel them, as shown in Figure 1.

2.2 Technologies Used in Assistive Devices for People with Disabilities

2.2.1 Wireless Local Area Networks (WLAN)

Wireless LAN is a technology that connects two or more devices using a wireless signal transmission method, as shown in Figure 2. With WLAN, the user can continuously access the network while moving around a short-range area such as a home, school, computer laboratory, campus, mall, or office building. It is an IEEE standard for wireless communications, and names usually start with IEEE 802.11 and have letters a, b, g, and n, depending on the version [6]. Since IEEE 802.11 is the only wireless LAN standard, all other wireless LAN standards begin with 802.11, also known as wireless fidelity or Wi-Fi [7]. To use Wi-Fi, you need an access point (AP). The router converts the Internet signal flowing on the LAN lines into a wireless signal, and you can use the "wireless" Internet without connecting the LAN line within the range of the signal. The WLAN can also extend its range through a gateway, providing a connection to the wider Internet.

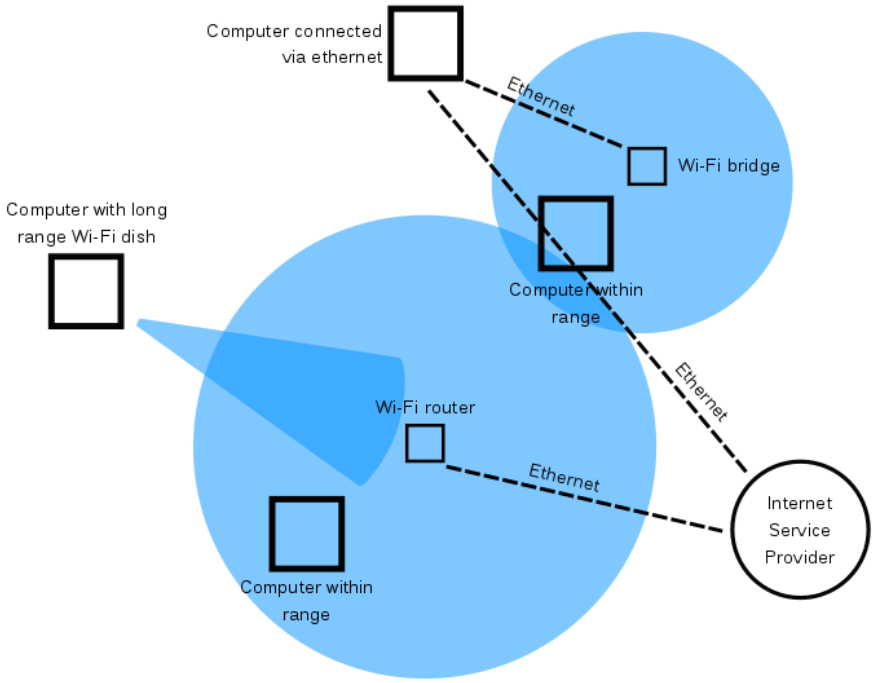

Figure 2. Wireless Local Area Network (WLAN) [8]

Wi-Fi evolved from Wi-Fi 1, which has 11 Mbps speed, to Wi-Fi 6, which has 9.6 Gbps speed, with bandwidth increasing exponentially [7], as indicated in Figure 3. The development of wireless communication technology is making our lives very easy. They can be used for homes and short-range areas that link together laptop computers, printers, personal digital assistants (PDAs), smartphones, Web TVs, and gaming devices with a wireless router, which links them to the Internet. The APs, known as hotspots, are provided by routers, that when connected to public areas including malls, restaurants, bus terminals, train stations, coffee shops, hotels, and airports, allow users to access the Internet with their portable wireless devices.

Figure 3. Wireless Local Area Network (WLAN) Evolution

2.2.2 Internet of Things (IoT)

The Internet of Things (IoT) is an object-space network that cooperatively forms intelligent relationships such as sensing, networking, and information processing without human explicit intervention for three distributed environmental elements: humans, objects, and services [9][10].

Objects, which are the main components of IoT, include not only end-devices in wired and wireless networks but also humans, vehicles, bridges, various electronic equipment, cultural assets, and physical objects that make up the natural environment, as shown in Figure 4. The concept of machine-to-machine (M2M), which can communicate intelligently between people and objects using mobile communication networks, has evolved into a concept that interacts with all information in the real and virtual worlds as well as objects.

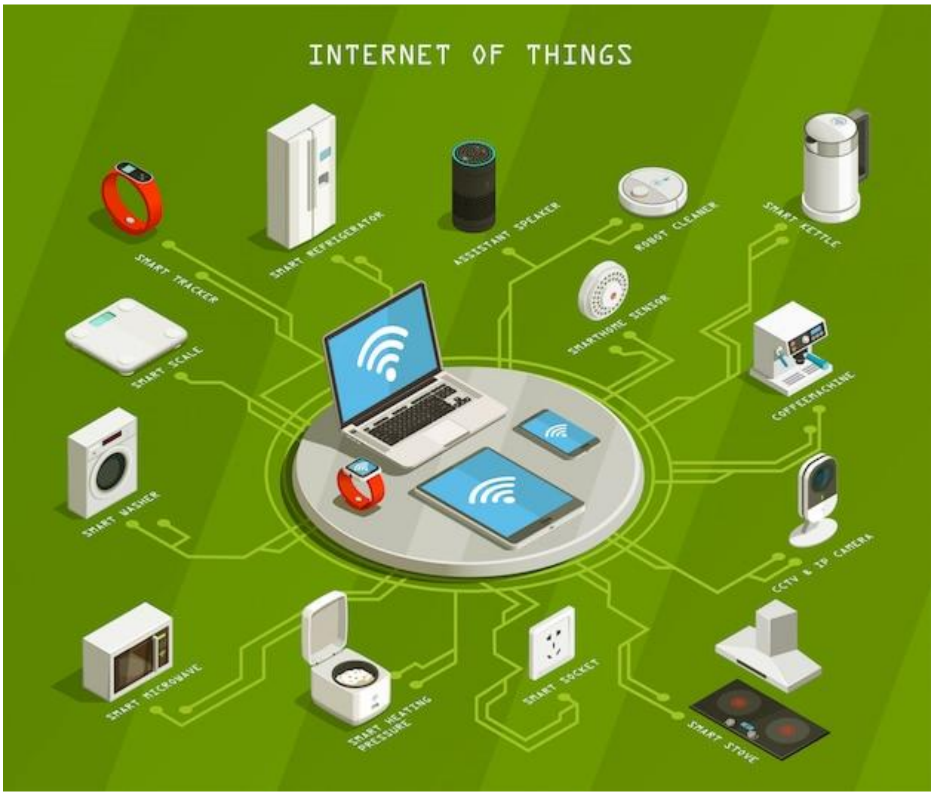

Figure 4. Internet of Things Isometric Flowchart [11]

IoT technologies include sensing technology, wired and wireless communication and network infrastructure technology, and IoT service interface technology. Physical sensors of sensing technology are developing into smart sensors with standardized interfaces and information processing capabilities to improve application characteristics. Virtual sensing technology is implemented in real IoT service interfaces [12].

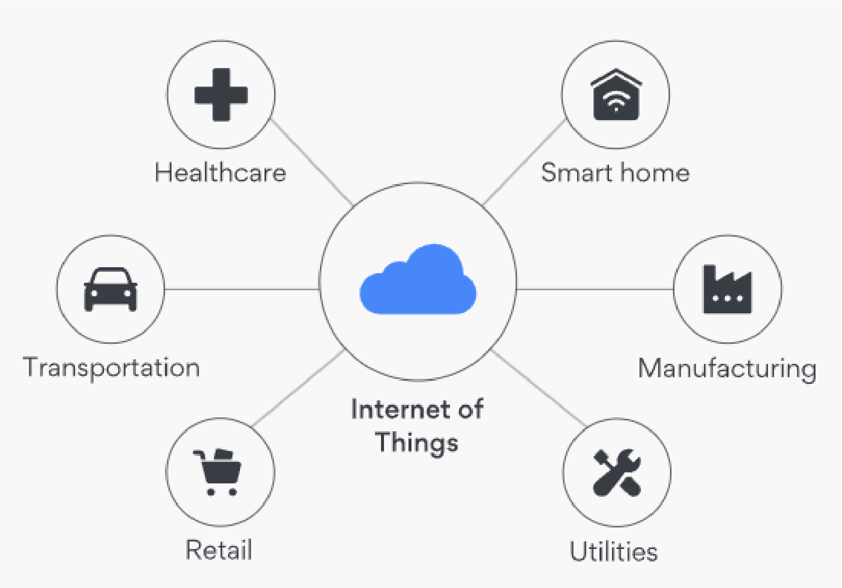

Figure 4. Internet of Things Applications

IoT has been implemented in various areas of applications, including transportation, smart homes and cities, retail commerce, utilities, manufacturing, and healthcare [13][14], as shown in Figure 5. Examples of IoT applications include personal IoT traffic light notification services for the visually impaired. It is a method of recognizing the color of traffic lights and communicating with a cell phone through beacon technology to inform them by voice.

3. Development of a Guide Service for the Blind

Blind people have difficulty identifying obstacles quickly when walking on the street. In order to walk safely in unfamiliar places, a road guidance system is needed to guide the path, considering obstacles [15-17]. To do this, it is necessary to provide a location-based service that searches for routes by identifying obstacle information detected from the smart movement assistance system.

3.1 Wearable Devices

The concept that tools are extensions of the human body is key. The device, which started with the wrist, is expanding its scope to glasses, shoes, accessories, T-shirts, and pants [18]. The current wearable device market is focused on making our lives more convenient and rich. It is not essential for a non-disabled person, but it will help someone improve their quality of life by becoming an eye, an ear, and a bridge. If a non-disabled and disabled person-free environment is created by utilizing the characteristics of these wearable assistants, society will be able to go in a more developed direction.

Ultrasonic sensors are used to immediately inform the visually impaired of the direction of the obstacle. The way to tell the direction of an obstacle is to immediately vibrate when an obstacle is found within a certain distance.

Figure 2. Wearable Devices

3.2 Global Positioning Systems (GPS)

The Global Positioning System (GPS) is a satellite navigation system consisting of at least 24 satellites [19][20]. GPS satellites orbit the earth twice a day through precise orbit. A GPS receiver calculates the exact location of the user using the identified information and trilateration. Essentially, the GPS receiver measures the distance to each satellite by using the time it takes to receive the transmitted signal. To calculate latitude and longitude and track movement, GPS receivers must capture at least three satellites. GPS can grasp the user's speed, distance to the destination, and direction by using the location. GPS can also be grasped through a wireless body network.

A route is searched by grasping information about an obstacle detected by a smart movement auxiliary system. The location of the obstacle is the GPS value obtained by converting the distance from the obstacle into latitude and longitude in the direction of the identified user. A user's position is grasped by GPS, and the location of nearby obstacles and a guide service are provided simultaneously. Information updated in the database is guided to the visually impaired by voice on a safe route free of obstacles.

Figure 4. Guide Service

4. Conclusions

In this paper, a road guidance service based on an obstacle map for the visually impaired is envisioned. The road guidance service envisioned this time provides a safe path for the visually impaired by considering obstacles through human-technical interactions. Currently, GPS has a margin of error of about 10 meters. However, for the blind, the error of 10m is a big figure. It is expected that high-precision GPS will be commercialized, and the range of services will gradually expand, allowing blind people to go wherever they want in the future.

References

[1] Laser Eye Surgery Hub, "*Visual Impairment & Blindness Global Data & Statistics*", www.lasereyesurgeryhub.co.uk/data/visual-impairment-blindness-data-statistics/ (Accessed January 28, 2023).

[2] World Blind Uniion, "*Vision Health*", www.worldblindunion.org/programs/vision-health/ (Accessed January 28, 2023).

[3] World Health Organization, "*Blindness and vision impairment*", www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment (Accessed January 28, 2023).

[4] C. Willings, "*Teaching Students with Visual Impairments*", www.teachingvisuallyimpaired.com/braille-technology.html Accessed January 28, 2023).

[5] Accessible Web, "*Assistive Technology Focus: Braille Devices*", www.accessibleweb.com/assistive-technologies/assistive-technology-focus/assistive-technology-focus-braille-devices/ (Accessed January 28, 2023).

[6] IEEE 802, "*IEEE 802.11 Wireless Local Area Networks*", www.ieee802.org/11/ (Accessed January 28, 2023).

[7] IEEE Standards Association, "*The Evolution of Wi-Fi Technology and Standards*", www.standards.ieee.org/beyond-standards/the-evolution-of-wi-fi-technology-and-standards/ (Accessed January 28, 2023).

[8] Wikimedia Commons, "*WI-FI Range Diagram*", www.upload.wikimedia.org/wikipedia/commons/d/df/WI-FI_Range_Diagram.svg (Accessed January 28, 2023).

[9] A. S. Gillis, "*Internet of Things (IoT)*", Tech Target, www.techtarget.com/iotagenda/definition/Internet-of-Things-IoT (January 28, 2023).

[10] IBM, "*What is the internet of things?*", www.ibm.com/topics/internet-of-things (Accessed January 28, 2023).

[11] Freepik, "*Internet of things isometric flowchart*", www.freepik.com/free-vector/internet-things-isometric-flowchart_6169717.htm#query=iot&position=3&from_view=keyword&track=sph (Accessed January 28, 2023).

[12] P. V. Dudhe, N. V. Kadam, R. M. Hushangabade and M. S. Deshmukh, "*Internet of Things (IOT): An overview and its applications*," 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS), Chennai, India, August 1-2, 2017, pp. 2650-2653, doi: 10.1109/ICECDS.2017.8389935.

[13] R. Mohanakrishnan, "*Top 10 Applications of IoT in 2022*", Spice Works, www.spiceworks.com/tech/iot/articles/top-applications-internet-of-things/ (January 28, 2023).

[14] A. Kostadinov and K. Kolev, "*Internet of Things Applications*," 2021 IEEE Engineering International Research Conference (EIRCON), Lima, Peru, October 27-29, 2021, pp. 1-4, doi: 10.1109/EIRCON52903.2021.9613595.

[15] Y. Oh and S. Min, "*G-eye: Route Guide System Based on Obstacle Map for Blind people*", Korean HCI Society conference, vol. 2017, no.2, 2017, pp. 703-705.

[16] S. Khan, S. Nazir, and H. U. Khan, "*Analysis of Navigation Assistants for Blind and Visually Impaired People: A Systematic Review*", IEEE Access, vol. 9, January 2021, pp. 26712-26734, doi: 10.1109/ACCESS.2021.3052415.

[17] B. Li, J.P. Munoz, X. Rong, Q. Chen, J. Xiao, Y. Tian, A. Arditi, M. Yousuf, "*Vision-based Mobile Indoor Assistive Navigation Aid for Blind People*", IEEE Transactions on Mobile Computing, vol. 18, no. 3, June 2018, pp. 702-714, doi: 10.1109/TMC.2018.2842751.

[18] N. D. Wanjari and S. C. Patil, "*Wearable devices*", in 2016 IEEE International Conference on Advances in Electronics, Communication and Computer Technology (ICAECCT), Pune, India, December 2-3, 2016, pp. 287-290, doi: 10.1109/ICAECCT.2016.7942600.

[19] Garmin, "*What is GPS?*", www.garmin.com/ko-KR/aboutgps/ (Accessed January 28, 2023).

[20] Tech Target, "*Global Positioning System (GPS)*", (Accessed January 28, 2023).