Smart Guidance System (SGS)

Ali Alawami*, Hassan Dobisi, Sadiq Alnaimi, Mohammed Alnajaidi, Mansor Alsubaie,Abdullah Alqahtani, Rami Abdel Rahman, Rachid Zagrouba

Imam Abdulrahman bin Faisal University, College of Computer Science and Information Technology, Dammam, Saudi Arabia

* Corresponding author. Email: alim.2000sa@gmail.com (A.A.)
Manuscript submitted February 18, 2023; revised May 8, 2023; accepted June 10, 2023; published March 1, 2024.
doi: 10.17706/jsw.19.2.29-41

Abstract: There is no doubt about the number of people with disabilities who face difficulties with their vision, the deaf, the hard of hearing, and others. These people face many challenges every day as they navigate many different areas to get to where they need to go. A guiding system must be available to assist users with impairments, such as blind people, hard-of-hearing users, and regular users, in finding certain offices and understanding for whom they are intended. The study was developed to assist users in finding their way to any office they want, especially for those with disabilities. The system will provide a solution to a common issue in society and provide a variety of features, such as voice and displayed information on the screen. Other than that, this project will save time, effort, and money for organizations by replacing old plates with tablets that offer different functionality and can easily change the information for that specific office without needing to buy new ones.

Keywords: Smart Guidance System (SGS), Near Field Communication (NFC), and Radio Frequency Identification (RFID)

1. Introduction

There are 246 million people with severe vision impairment, and there are about 39 million people who are legally blind worldwide [1]. There is no doubt about the number of people with disabilities who face chronic diseases that affect their eyesight, the deaf, and others. These people face many challenges every day as they navigate many different areas to get to where they need to go. It is necessary to use and control some sensory cues from the outside world for this type of road detection. Usually, 3D maps are produced by sighted people using information from their visual senses. However, blind people use other cognitive and attention resources.

People who are blind from birth or who became blind early in life encode the sequential characteristics. Visually impaired people rely on a wand to understand environmental information. Using it, they can understand the situation by detecting changes in walls, including angles and floor height. When the place type changes, select their next actions, such as finding braille signs next to the door, turning left or right according to the angle, or going up the stairs. Sighted people can navigate unfamiliar indoor environments even if they do not have structural information because they can locate necessary information from visual clues such as objects and signs within the environment. The common point between them and the blind is that they all require different types of information according to their condition. For example, when sighted people stand in front of the door, they need information about the room number to know if it is their intended destination. For an intersection or hall, they need directional information about their destination.

The purpose of our project is to facilitate the methods for these groups and make it easier for them to move around in workplaces, schools, universities, hospitals, etc. This project will be able to make it easier, more comfortable, and smoother for them than the usual methods in terms of activating these existing capabilities and making it at the same time more efficient and less costly. The project will involve Placing Radio Frequency Identification (RFID) and Near-Field Communication (NFC) tags next to every door in the building. Each tag contains an identifier that a smartphone can read through the developed app. A smartphone's RFID (NFC) reader sends the tag's ID to the app, which then sends a voice note describing the location to the user. It will be much easier for blind people and organizations in easier ways and at lower costs.

2. Background and Review of Literature

2.1. The Impact of Information Technology

Information technology plays a role in developing the quality of human life, and it will contribute to achieving the Kingdom's Vision 2030. In the education sector, online degrees are obtained via the use of information technology. Numerous educational opportunities are made available by modern technology, which also makes things much simpler for people. Since the establishment of online degree programs, attending classes in person is no longer strictly necessary. A few foreign universities have even begun offering online degree programs to students [2]. In the health sector, using IT to better understand time spent on tasks and activities and how long task execution takes This method will promote better patient care. Both quantitative and qualitative methods will be used in the evaluation's mixed-methods case study methodology to gather the necessary data. Because the combined use of both the qualitative and quantitative methods in a single review will produce results that a single approach may not yield, using mixed methods offers more evidence and a deeper understanding of the outcomes [3]. In the commercial business sector, system, product, and service efficiency are increased because of technology. It assists in managing contacts and employee records, maintaining data flow, and tracking and streamlining operations. By running operations more efficiently, the company can save costs and expand quickly. A market-leading ERP and CRM solution that can be used across all departments is beneficial to commercial businesses. As a Microsoft Gold Partner, Arctic IT offers the robust Microsoft Dynamics 365 platform to give the business staff the security, comfort, and dependability they require [4]. Finally, there is a lack of research and IT-based projects that have been used to help people with disabilities. Finally, there is a lack of research and IT-based projects that have been used to help people with disabilities.

2.2. Smart Cities and Smart Buildings

One of the advantages of smart cities and smart buildings is the use of information technology to reduce material costs and save money. For example, video camera-based crowd management systems offer very important advantages over Wi-Fi-based solutions, such as the possibility to reuse existing infrastructure (e.g., traffic cameras), the possibility to increase their accuracy based on new developments in image and video recognition, or the near real-time feedback provided. However, this technology is highly dependent on visual aspects (such as weather conditions, environmental changes, etc.), and the additional costs associated with its deployment can increase depending on the area to be monitored. Even if the data is properly anonymized, they still must deal with the privacy issues that are inherent in the usage of video cameras and that are quite restrictive in many countries [5]. Despite this, it still finds that there are some buildings that use traditional panels that are expensive to maintain and change, for example, the office's panels in the building of the College of Computer Science and Science Technology (A11), as shown in the following Fig. 1.

Fig. 1. Panel example.

2.3. Proposal Supporting People with Needs

Although there are some proposals and projects that have contributed to helping people with special needs, there is a weakness in the research that has invested information technology in helping people with special needs. For example, this proposal focused on individual blind people who throw a set of digital signs (tags). These tags will contain Data Matrix 2-D bar codes; this tag will be read by a custom tag reader that consists of a camera, lens, and IR illuminator; this reader will contact a smart phone through USB and throw an application into the phone (high cost) [6]. In addition, another proposal suggested a system to guide blind and visually impaired people to and from their destination of choice in unfamiliar indoor environments to fulfill their accessibility and mobility needs. Here, the primary target user population is people with low vision or blindness (one category of people with special needs) [7]. Therefore, a proposal should be provided to overcome this weakness.

2.4. Indoor Sign Recognition for the Blind People

Exploring unexpected environments is challenging for some individuals. They are unable to use the information posted on indoor signs and notice boards. We offer real-time technology that can help them with this problem by allowing them to identify a variety of indoor navigational indicators placed over transparent backgrounds. The requirement to support blind people's navigational needs has been overlooked by technological advancements over the last few decades. Persons with visual disabilities frequently need greater support with daily tasks compared to people with other disabilities. We have devised a computer vision system that may help those who are blind or visually handicapped read signage inside buildings. This system is still a work in progress and has its limitations. It demands that the signs be precisely positioned on plain backgrounds that differ in color from the signs [8].

2.5. Indoor Navigation by People with Visual Impairment Using a Digital Sign System

In this project, blind people will be Supported by Digital Signs (tags) containing 2-D Bar Codes (QR), which will be read by a custom tag reader that includes a camera, lens, and IR illuminator. To allow the user to listen to a description of a place or room, the reader will be connected to a smart phone through USB and a phone application. There are some disadvantages to this method of indoor guiding for blind people, including the cost of the tag reader and the reliability of the Tag (QR), for example, if an object blocks the tag or the tag colors fade over time [6].

2.6. A Vision-Based Wayfinding System for Visually Impaired People Using Situation Awareness and Activity-Based Instructions

In this project, blind people will also be helping to find their way through a new smart phone route-finding system that can automatically recognize the situation and scene objects in real time. By analyzing the streaming images, the proposed system first classifies the user's current situation in terms of its location.

Based on their location, only necessary context objects are found and interpreted using computer vision techniques. It estimates the user's movements using two inertial sensors and records the user's paths towards the destination, which are also used as a guide for the way back after reaching the destination. Design two types of QR codes: one that encodes the location information and the other that encodes the directional information. These QR codes are attached according to the type of place. The proposed system was implemented on the iPhone 6, which has a built-in camera, gyroscope, and accelerometer. It consists of five processing modules: situational awareness, object detection, object recognition, user path logging, and activity-based learning. However, stable communication between the server and the mobile phone user is not guaranteed due to the interruption of the signal or the traffic [7].

2.7. Indoor-Guided Navigation for People Who Are Blind: Crowdsourcing for Route Mapping and Assistance

The paper described in this work uses social outsourcing of indoor route mapping and assistance procedures to improve Electronic Traveling Aids (ETAs) for people who are blind or severely visually impaired (BSVI) using indoor orientation and guided navigation. Due to poor GPS performance and a lack of or prohibitively expensive infrastructure investments for indoor navigation, this type of strategy is required. The paper suggests obtaining vision-based recordings of indoor routes in advance from an online community of volunteers who are visually impaired. These participants collect and regularly update a web-based database of indoor routes utilizing specific sensory tools and web services. Sensory data is processed by algorithms based on computational intelligence before being used by BSVI. In this way, people who are BSVI can obtain ready-to-use access to the indoor routes database. This type of service has not previously been offered in such a setting. Specialized wearable sensory ETA equipment, depth cameras, smartphones, computer vision algorithms, tactile and audio interfaces, and computational intelligence algorithms are employed for that matter. The integration of semantic data of points of interest (such as stairs, doors, WCs, entrances and exits) and evacuation schemes could make the proposed approach even more attractive to BVSI users. The presented approach crowdsources volunteers' real-time online help for complex navigational situations using a mobile app, a live video stream from BSVI wearable cameras, and digitalized maps of buildings' evacuation schemes. Every proposal has positives and negatives. However, the information here could be wrong or not clear because it was done by society, so the analysis of the collected data has a lack here. People may not participate in the guidance. By using volunteers instead of expensive infrastructure like RFID tags and beamers, the indoor routing process might be crowdsourced. Using the advantages of Web 2.0 social networking for guided interior navigation, this paper explored its feasibility after analyzing pertinent research papers [9].

2.8. NFC Technology

NFC technology played an important role and contributed to the development of many works in various fields. For example, the use of NFC in mobile payments Today, any NFC-enabled mobile phone can be used to make payments in a very simple and convenient manner. For example, Apple Pay technology, which uses Near Field Communication (NFC), has been very popular in the last few years for its simplicity and security. Despite this, there were no projects or proposals that used NFC to support and facilitate access services for people with special needs inside buildings [10, 11].

3. Aims and Objectives.

This project aims to enhance the way of reaching specific locations inside buildings, this can be achieved by fulfilling the following objectives:

- Build a framework of SGS with a focus on helping blind people through providing multiple ways to reach a specific office.

- Establish communication between different kinds of devices and to be able to send and retrieve databetween devices.
- Ensure supporting voice commands to give the blind people the directions they needed to reach out specific office.
- Apply several testing procedures to ensure the quality of the developed system.
- Create a literature review to comprehend the gaps that were introduced in other case studies.

4. Scope/Limitation of the Study

This prokect will provide indoor guidance as voice guidance for individuals with blind disabilities and as voice, visual (by monitor) or both guidance for non-blind individuals. project will use tools that can be used by most people without buying custom devices. This way, everyone can use it without spending a lot of money. It will also help with the limited resources we have for this project.

Limitations:

- Limited distance: Tags can only be read by smart phones at a maximum distance of 10 cm.
- Smart phone support: RFID (NFC) technology isn't supported on older smart phones, and some new smart phones don't either.

5. Product Perspective

The SGS is a system that describes real-time software for three types of users: blind, hard of hearing, and normal. The main goal of SGS is to help users with disabilities by providing a solution using tablets, NFC tags, databases, and mobile devices to support organizations while reducing costs. Based on the user's authority, whether he is an admin or a normal user, he will grant his authority. Users and administrators need to connect to the internet to use and interact with the application. Also, the NFC in mobile phones should be enabled by the user, especially the blind, to use scanning functionality. Finally, the SGS needs a database to store and retrieve the required information.

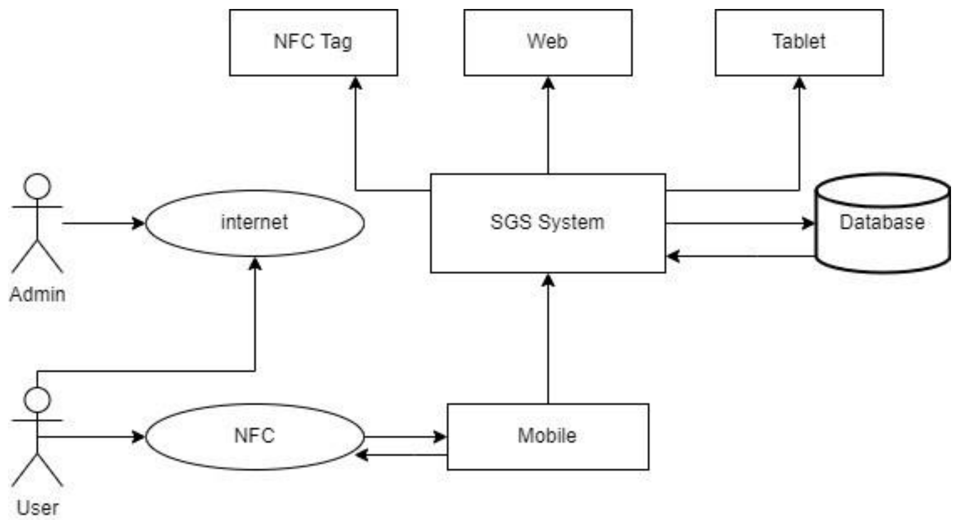

Fig. 2. Product perspective.

5.1. Hardware Interface

In SGS, smart phones, tablets, and RFID (NFC) will be used as attached hardware. To take advantage of the SGS system, the user must have a smart phone that supports NFC technology and has an NFC reader. This ID will represent the current location of the user, allowing the system to provide directions for the user based on the unique ID carried by the RFID (NFC) tag. As shown in the following figure, tablets will provide information about rooms for normal individuals using tablet screens. Figure 3 explains the scenario of the system.

Fig. 3. Hardware interface.

5.2. Communication Interface

According to the following Fig. 4, the SGS system consists of many parts that communicate with each other to achieve its goal. A smart phone or tablet will display the stored information in a database with the help of the SGS system, and a smart phone will send information to a text-to-Speech API so they can give a description of places or rooms. An RFID (NFC) tag will store the IDs of places and rooms, which will then be readable by a smart phone's built-in NFC rendering. IDs will be used to restore data from databases.

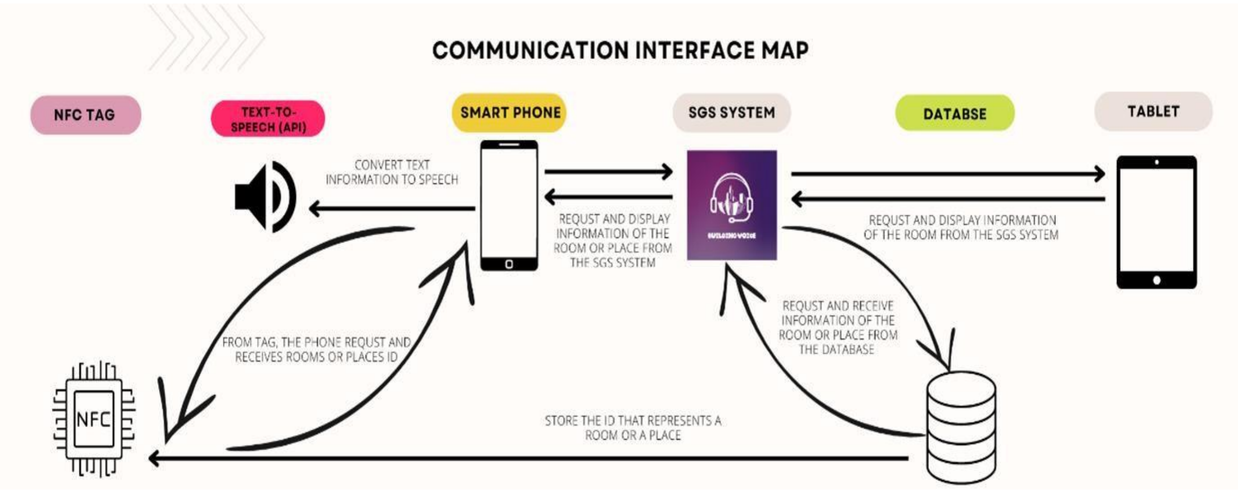

Fig. 4. Communication interface

5.3. Data Description

The system will store and manage all information that is retrieved or entered using Subapase as an efficient relationship model. The data will include major entities in the system along with their attributes. Employees, locations, sections, and RFID (NFC) tags are the main entities of the system. The database will store theinformation about those entities and their attributes. As a result, queries in the database will be easier to retrieve.

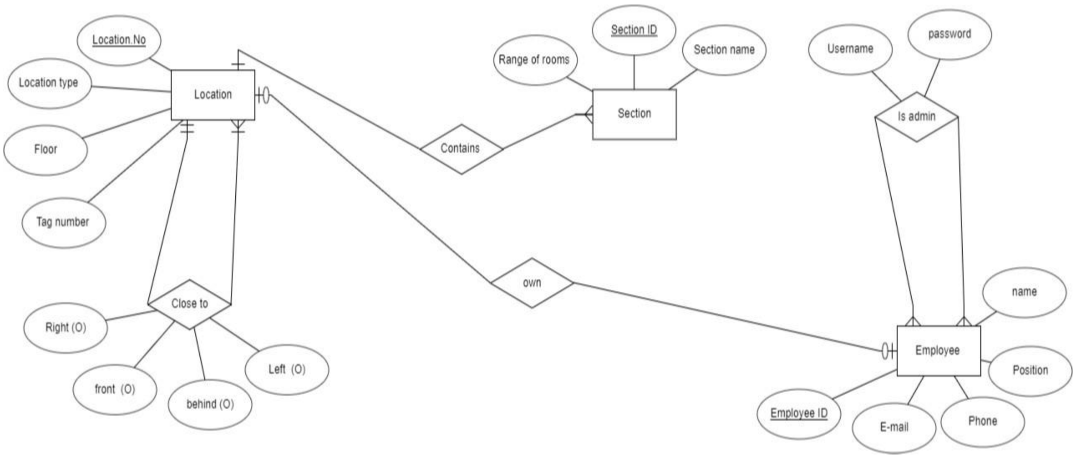

Fig. 5. Entity relationship diagram

5.4. Methodology

The smart guidance system uses a waterfall model, as shown in figure 6. As the waterfall uses a step-by-step process, it indicates that the first phase should be done completely before moving forward to the next one. By using this method, you are guaranteeing the success of the project.

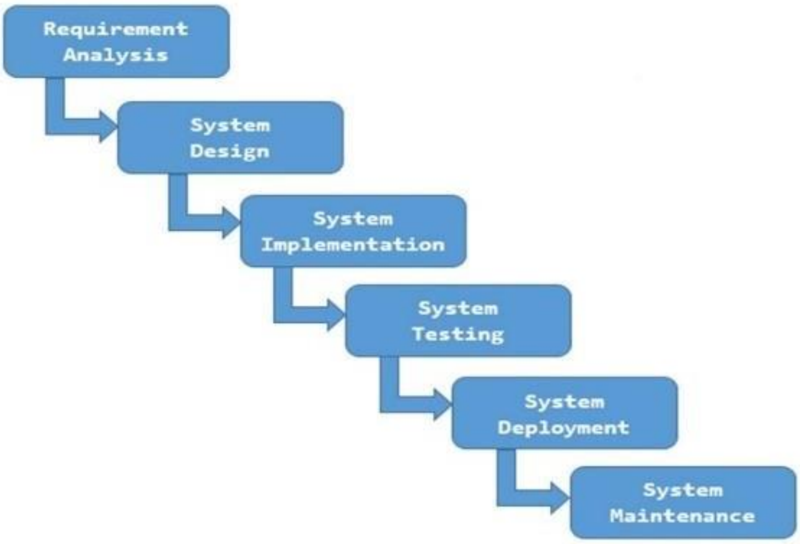

Fig. 6. Waterfall methodology.

6. Implementation

6.1. Home Page Interface

This page shown (7) will appear to the user when they open the app. On this page, the user will scan the NFC, which is connected to the database, and it will display the information that the NFC contains. On the other hand, the user can press the history button to display information they have already scanned. All phone pages have descriptions on their widget, which would allow the user to hear information if they enabled accessibility.

Fig. 7. Home page user interface.

6.2. Location Information Interface

After scanning the NFC, the app will show this page shown in figure 8. It is called the Room Location Information page and contains a room number, room details, and contact information. After scanning, this room will go to the history, so whenever the user presses the history button, this room will show all rooms that have been scanned before.

Fig. 8. Location information interface.

6.3. Current Location Interface

This page in Figure 9 will appear when the user scans some places between the halls that have only NFCs that contain information about the user's current location and what is close to the user in all four directions: left, right, behind, and front of the user's current location.

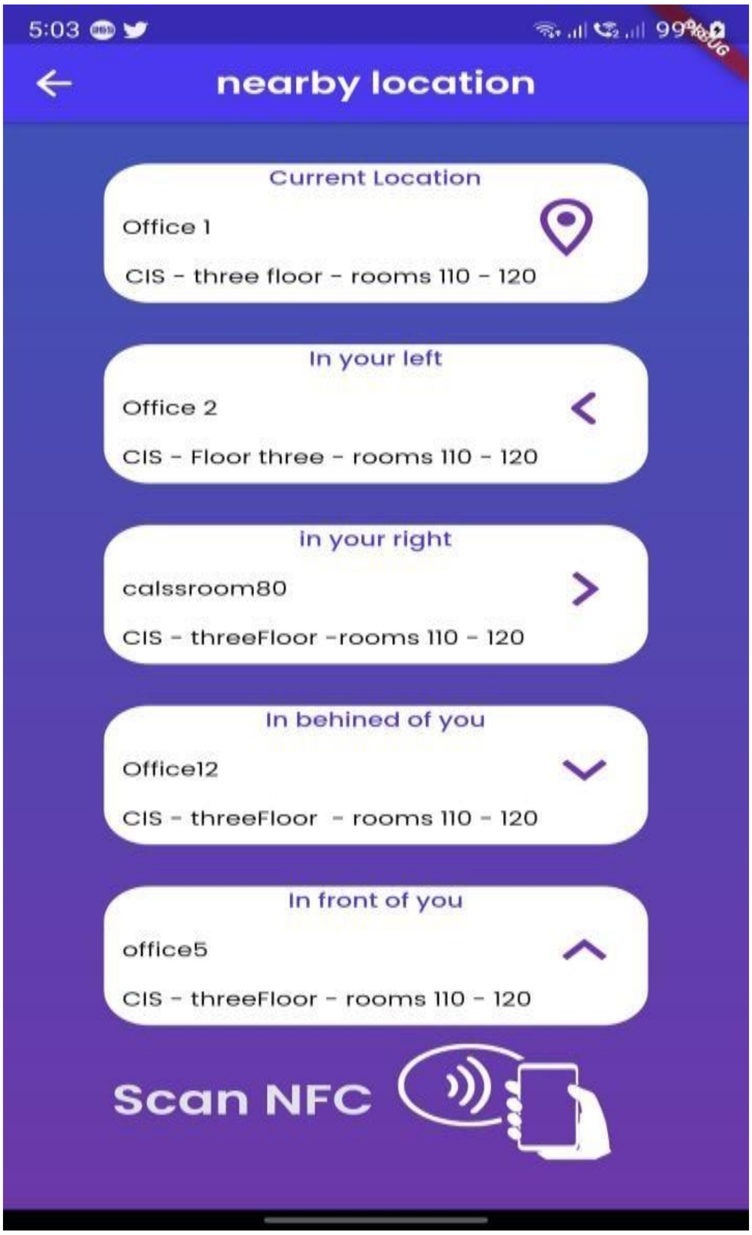

Fig. 9. Current location user interface

6.4. History Interface

This page shows the history of old scanned NFCs. The user will be able to see every room detail that has been scanned and press on the name of the room. After pressing on the name, a new page will open that will contain all the information about this room. The user can use the arrow next to the history word to go back to the history page. The user can remove the visited places by pressing the recycle button, as shown in Fig. 10.

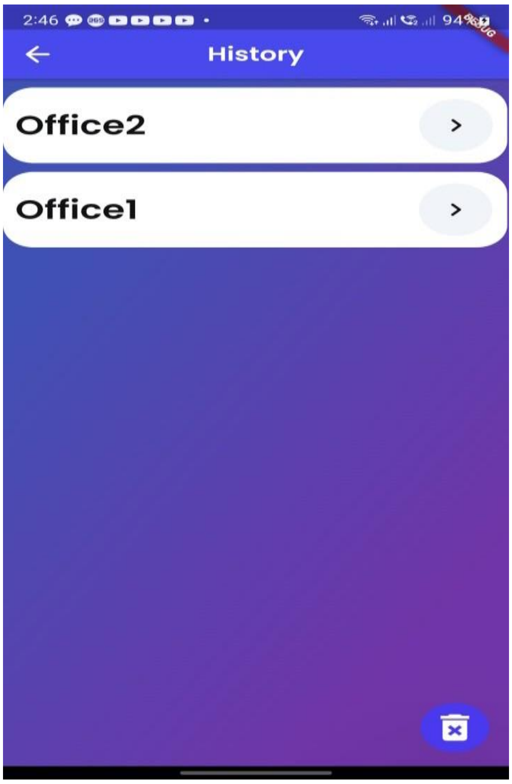

Fig. 10 History user interface.

7. Result/Analysis

In this project, the developers have used a survey to get feedback from users. The study has been done on 20 users from the College of Computer Science and Information Technology in one of its labs to get feedback about the system's performance. So, the result of the assessment is that the developers got information from 19 users who don't have a disability and one who does. As shown in figure (11): 8 are from a beginner user, 7 are from an individual user, and 5 are from an expert user. So, that will help the developers know how far the users have come.

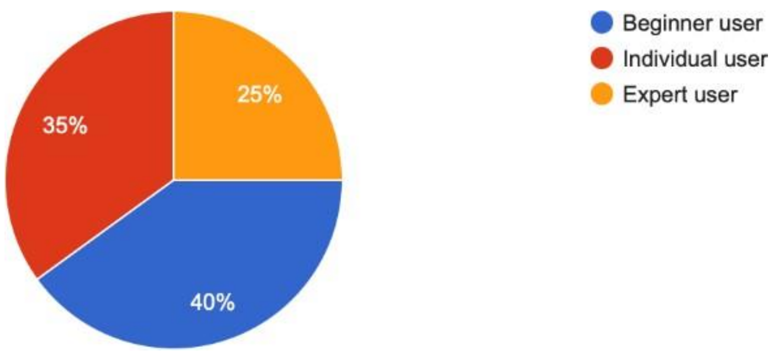

Fig. 11. User experience of application.

The survey measures the application's performance. So, the user rated the system's performance from 5 (excellent) to 1 (bad), 16 responses were between 4-5, and four responses were between 2-3. The user also rates the system's alert. So, all responses were from 3-5; this gives the developer a good rating for the system alerts. As shown in Fig. 12, the user rates the system information and how valuable it is; most responses were between 4 and 5, so the system information was excellent.

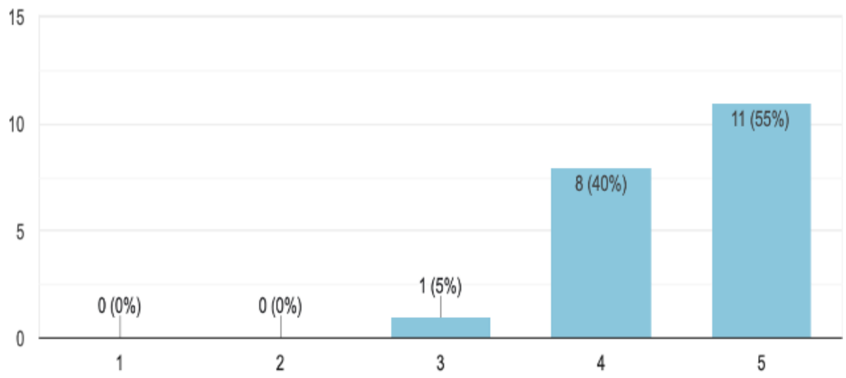

Fig. 12. Rate of the valuable information.

The rating of the system directions was good since most respondents' results were between 4 and 5, and 2 respondents only rated 3. The next question was measuring the number of users who face a system bug and then choosing what the bug was. Only one user faces two bugs, as shown in Fig. 13.

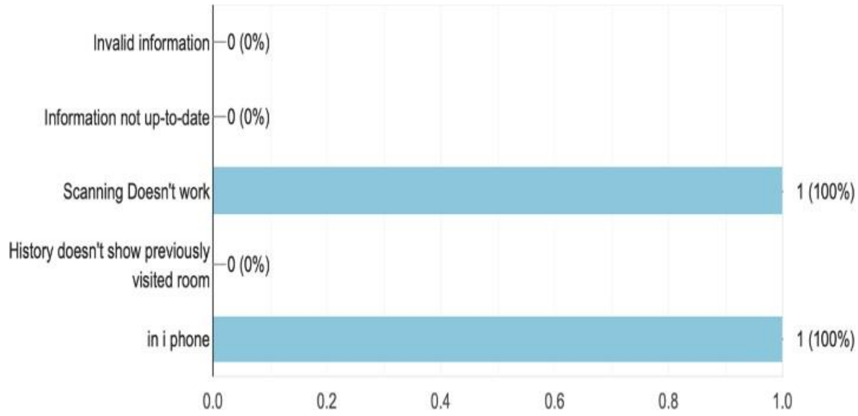

Fig. 13. Kind of bugs faced.

Fig. 14 shows the reasons that users faced issues with the system's formatting. The total number of users who did not face an issue is 19, and only one had a formatting issue.

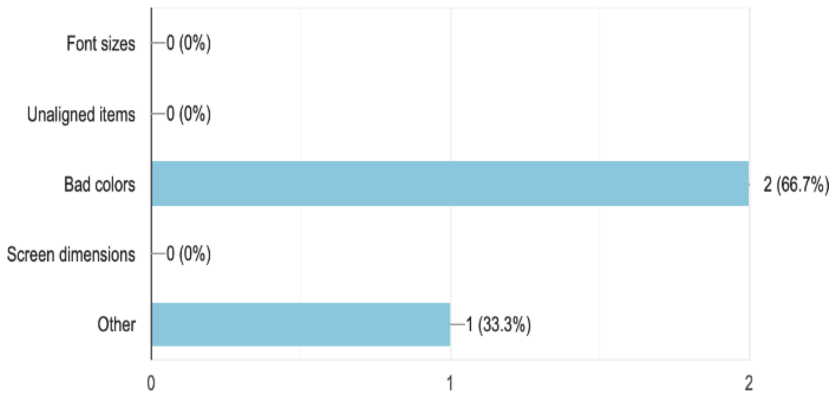

Fig. 14. Formatting issue.

The most feature that gets the user's attention is the overall permeance of the system, and the least important is the valuable information, as shown in Fig. 15.

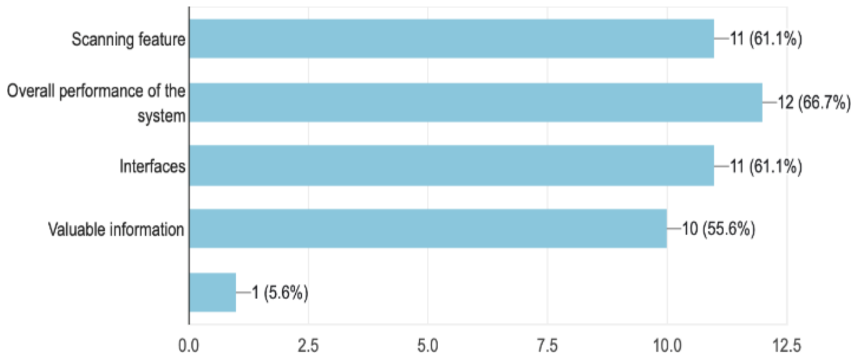

Fig. 15. Performance of the system.

The survey asked the users about their ability to identify what parts of the system need improvement, and their responses were mostly in the areas of system functionality, user interface, and system performance, respectively. Users also rate the system's overall experience, and the result is that all the users rate the system between 4 and 5, except for one user who rates the system 3. So, developers can measure user satisfaction; 95% of them are satisfied with the system, as shown in Fig. 16.

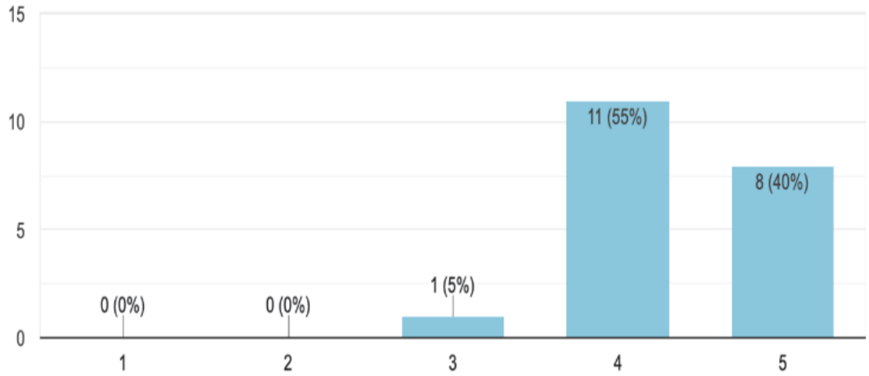

Fig. 16. User overall experience.

8. Conclusion and Future Work

In conclusion, the Smart Guidance System is a project that helps people with disabilities, lack of vision, and normal people find their way inside buildings. So, as an example, this project uses the CCSIT to implement the system. The admin can manage the employees, sections, and locations by adding, modifying, or deleting any information, and it will be updated at the same time. The user in his or her role can scan the NFC tag to be able to navigate to the room, section, or office as recorded in the tag. The guidance will be displayed on the screen, and to start listening to the directions, the user should activate accessibility. This process will ensure that users save time and effort when they are looking for specific locations inside big buildings, and it will save costs for the organizations when they keep changing the plates inside the building by using the tablet, which will display room information and employee contact information if they need to reach any employee.

Future work consists of the further features and functions that are anticipated to be added to the system in the future for further advancements. The following points show the future plan:

- Using accurate GPS next to the NFC for better navigation.
- Adding filter to listen to information.
- Adding Arabic language to the application.
- Better voice cover for the application.
- Using the camera of the phone to direct the blind users to the tags by using AI.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Mr. Ali and Mohammed conducted the research, gathered the data required for the study, involving experiments, surveys, and data collection procedures, Formatted the paper. Mr. Hassan, Mansour, and Sadiq focused on analyzing the data collected during the research. They performed statistical analyses, interpreted the results, and drew conclusions based on the findings. Dr. Abdullah, Rami, and Rachid verified and validated the data analysis techniques utilized in the research and assisted in the interpretation of the findings. Criticize the paper to help enhance it. All authors contributed significantly, provided criticism, and helped develop the research paper.

References

[1] Bourne, R. R. A. *et al.* (2021). Causes of blindness and vision impairment in 2020 and trends over 30 years, and prevalence of avoidable blindness in relation to vision 2020: The right to sight: An analysis for the global burdenof disease study. *The Lancet Global Health*, *9(2)*, e144–e160.

[2] Raja, R., & Nagasubramani, P. C. (2018). Impact of modern technology in education. J*ournal of Applied and Advanced Research*, S33–S35.

[3] Kesiilwe, A. B., Lederman, R., Dreyfus, S., & Knott, J. (2018). A time motion study evaluating the impact of information technology on emergency department consultants activities. *Proceedings of the 26th European Conference on Information Systems: Beyond Digitization - Facets of Socio-Technical Change*, ECIS 2018.

[4] Commercial Technology Services, Business Technology Services - Arctic IT. (n.d.). Retrieved October 14, 2022, from https://arcticit.com/commercial-business-technology-services/

[5] Santana, J. R., Sanchez, L., Sotres, P., Lanza, J., Llorente, T., & Munoz, L. (2020). A privacy-aware crowd management system for smart cities and smart buildings. *IEEE Access*, *8*, 135394–135405.

[6] Legge, G. E., Beckmann, P. J., Tjan, B. S., Havey, G., Kramer, K., Rolkosky, D., Gage, R., Chen, M., Puchakayala, S., & Rangarajan, A. (2013). Indoor navigation by people with visual impairment using a digital sign system. *PLoS ONE*, *8(10)*.

[7] Ko, E., & Kim, E. Y. (2017). A vision-based wayfinding system for visually impaired people using situation awareness and activity-based instructions. *Sensors*, *17(8)*, 6–32.

[8] Kunene, D., Vadapalli, H., & Cronje, J. (2016). Indoor sign recognition for the blind. *ACM International Conference Proceeding Series.*

[9] Plikynas, D., Indriulionis, A., Laukaitis, A., & Sakalauskas, L. (2022). Indoor-Guided Navigation for People Who Are Blind: Crowdsourcing for Route Mapping and Assistance. Applied Sciences (Switzerland), 12(1).

[10] Pal, D., Vanijja, V., & Papasratorn, B. (2015). An empirical analysis towards the adoption of NFC mobile payment system by the end user. *Procedia Computer Science*, *69*, 13–25.

[11] Liebana-Cabanillas, F., García-Maroto, I., Munoz-Leiva, F., & Ramos-de-Luna, I. (2020). Mobile payment adoption in the age of digital transformation: The case of apple pay. *Sustainability*, *12(13)*, 1–15.

[12] Disability and health. (n.d.). Retrieved October 8, 2022, from https://www.who.int/news-room/fact-sheets/detail/disability-and-health

[13] Risk monitoring – Skillmaker. (n.d.). Retrieved October 8, 2022, from https://www.skillmaker.edu.au/risk-monitoring/

[14] Pros and Cons: The Use of RFID for Inventory Management. (n.d.). Retrieved October 8, 2022, from https://veridian.info/inventory-managemen/

[15] Meliones, A., & Sampson, D. (2018). Blind museumtourer: A system for self-guided tours in museums and blind indoor navigation. *Technologies*, *6(1)*