Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 4 (2023)

ShopEyes : Shopping Application for Visually Impaired

D. I. De Silva[1],M. V. N. Godapitiya[2],Y. A. I. D Yapa[3], A. P. J. K.V. Gunawardana[4], U. N. H. Madhuwantha[5], G. K. G. Saranga[6]

Faculty of Computing, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka

Abstract:-In this research paper, we delve into the pressing issue of independent grocery shopping for visually impaired individuals. Despite the inherent challenges they face, we identify a range of design requirements for assistive shopping systems that can significantly improve their shopping experience. To evaluate existing solutions, we conduct a comprehensive analysis of various approaches and their capabilities in meeting these requirements. The primary objective is to illuminate potential directions for research and development within the accessible visually impaired shopping community while offering valuable evaluation tools to designers of accessible shopping solutions. This lies in six pivotal components: Shopping-Cart Management, Shop Management, Product Identification, Voice Navigation, Instant shopping lists, Haptic Feedback. Through this research, we aim to enhance the independence and convenience of visually impaired individuals when navigating modern supermarkets, transforming their shopping experience by using a complete mobile solution called “ShopEyes”.

Keywords*: Visually impaired individuals, Visual Impairment, Independent Grocery Shopping, Accessibility*

1. Introduction

What would it take for people who are visually impaired to independently shop at modern supermarkets? If they do not know somebody who is visually impaired personally, many sighted people may never ask themselves this question. Many visually impaired individuals do not shop independently, in contrast to sighted people. They frequently depend on close friends, relatives, volunteers, and store employees. Customers who are visually impaired must reschedule or postpone their shopping trips if these people cannot be reached. They experience delays when going to supermarkets on their own because they must wait for staff to assist them.

Some employees are not familiar with the structure of the shop, others get frustrated by lengthy searches and requests to read the product contents out loud, and still others do not speak English well enough to read the ingredients on the items or respond to simple inquiries regarding the layout of the supermarket. Due to these challenges, consumers stop looking for preferred products, accept far-off substitutes, or, in the worst-case scenario, give up on independent shopping altogether.

For sighted individuals, navigating a large supermarket, finding the desired product's shelves, grabbing it from the shelf, identifying it, and comparing it to other products may not seem like a major difficulty. These factors add to the inconvenience of their shopping excursion.

Thus, it was determined to use contemporary technologies to offer a solution to this issue. ShopEyes is a mobile application created to overcome the prior problems with shopping for those with visual impairments. The primary goal of this application is to improve and facilitate the shopping experience for people who are visually impaired. A mobile device was created because of the problem's solution. A mobile application has been developed as the solution to this issue for several reasons. First and foremost, modern smartphones provide accessibility features for users with disabilities. A basic mobile application contains some accessibility features, requiring the user to merely bring his phone when out shopping. Another important factor is that a mobile

application is simple to use, easy to install, and affordable for everyone because it does not require expensive, tedious equipment.

Here we mainly focus on 6 major components: Shopping-Cart Management, Shop Management, Product Identification, Voice Navigation, Instant-shopping and Haptic feedback.

2. Objectives

Numerous initiatives have attempted to solve this issue, but most of them were unable to manage all the difficulties that the visually impaired encounter when shopping. Furthermore, most of them are too expensive for these folks to afford. In addition, they contain cumbersome to use and transport hardware.

ShopTalk [1] [2], iCare [3], TapTapSee [4], BeMyEyes [5] [6], and Shopvia [7] are some of conference papers and mobile applications that have addressed this problem. However, they were only able to meet a small portion of their buying needs.

As detailed in ShopTalk [1], primarily facilitates for visually impaired people through verbal route directions and barcode scans. In contrast, this novel application offers a more comprehensive shopping experience for the visually impaired. Both applications include audio feedback, voice-guided indoor navigation, product identification, and shopping list management. However, this stands out with two distinctive features: real-time instant shopping list maintenance, streamlining the shopping process, and the incorporation of haptic feedback for tactile cues. Notably, both apps prioritize user convenience by eliminating the need for external hardware devices.

As detailed in the research paper [3] the iCare application primarily focuses on aiding the visually impaired with various functionalities. In comparison, this newly developed application offers a comprehensive set of features for a heightened shopping experience. Both applications include essential features like audio feedback, indoor navigation with voice-guided routing, product identification, and shopping list management. However, it distinguishes itself by introducing three unique functions: real-time instant shopping list maintenance, efficient shopping list management, and the integration of haptic feedback for enhanced user interaction. Additionally, both applications prioritize user convenience by eliminating the need for external hardware devices.

This newly developed application offers an extensive set of features tailored for visually impaired individuals, while "Shopvia" as presented in the [7] focuses on empowering visually impaired shoppers. Both applications include essential functionalities such as audio feedback, indoor navigation with voice-guided routing, product identification, and shopping list management. However, this distinguishes itself by offering two unique features: the ability to maintain a real-time instant shopping list, streamlining the shopping process, and the integration of haptic feedback for an enhanced user experience. Notably, both applications excel in user convenience by eliminating the need for external hardware devices.

TapTapSee [4], is a mobile camera application designed specifically for visually impaired and visually impaired users, powered by the Cloud Sight Image Recognition API. TapTapSee utilizes your device's camera and Voiceover functions to take a picture or video of anything and identify it out loud for you. This application mainly focuses on picture recognition.

The restrictions in the projects are typically overcome by ShopEyes, which offers a superior and comprehensive set of solutions. TABLE I compares various products that are similar.

TABLE I. COMPARISON BETWEEN SHOPEYES AND SIMILAR SYSTEMS.

	ShopTalk	iCare	TapTapSee	BeMyEyes	Shopvia	ShopEyes

Audio Feedbacks	Yes	Yes	No	No	Yes	Yes
Indoor navigation with routing over voice commands	Yes	Yes	No	Yes	Yes	Yes
Keeping an Instant Shopping List	No	No	No	No	No	Yes
Product Identification	Yes	Yes	Yes	Yes	Yes	Yes
Manage Shopping List	Yes	No	No	No	Yes	Yes
Haptic Feedbacks	No	No	No	No	No	Yes
Non-usage of External hardware devices	No	No	Yes	No	No	Yes

3. Methods

The following system modules were able to get rid of all the mentioned inconveniences.

Making a list of the items you need or want is always a smart idea, whether you're shopping alone, with a friend, or with store staff. This will make it much simpler for you and the person assisting you to locate the items [8]. Through this function it allows them to create, manage, and organize their shopping lists using voice commands or a simplified user interface. After adding items to the shopping list, the user can listen to it anytime also. Then the application can read out the list and provide updates on crossed-off items. The unique feature is that the user can check the store's inventory from their home. It may save their time.

The voice navigation menu in this shopping application for visually impaired individuals offers a seamless and intuitive way to explore and interact with the app's features. Using natural language prompts, users can effortlessly navigate through departments, search for products, and manage their shopping lists. The voice-guided menu ensures that every step, from selecting items to completing purchases is described audibly. That empowers users to shop independently and confidently. With this voice navigation, shopping becomes an inclusive and enriching experience for all users, regardless of visual impairment.

Product identification feature revolutionizes visually impaired users' shopping experience. The app can swiftly identify and describe products using the device's camera. When users scan the barcode of a product, they receive instant and detailed audio feedback about its attributes, price, and any available promotions. This innovative solution empowers users to make informed purchasing decisions without relying on sight, fostering independence and inclusivity in the shopping process. With product identification, the app ensures that every user can confidently select items that meet their needs and preferences.

This component empowers shop owners to effectively handle the inventory of items and shopkeeper can view, manage and keep up to date records of items. Additionally, the system enables them to provide real-time availability status of items to customers, helping them avoid unnecessary visits to the store. Furthermore, this component helps to shopkeepers to managing work in more user-friendly manner. This streamlined process enhances the experience and reduces inconvenience for both customers and shop owners alike, fostering a sense of convenience and satisfaction for both parties.

As shown in **Fig. 1**, the Android mobile application connects via web services to the back-end services in order to perform its functionalities, including retrieving item locations and obtaining product details.

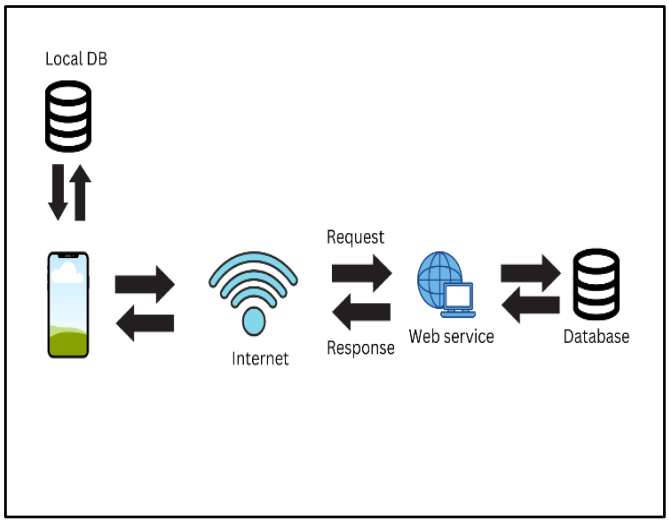

Fig. 1. Application access database using web services.

The Instant Shopping List feature within the proposed application addresses a core challenge faced by visually impaired individuals during shopping. By leveraging voice recognition and text-to-speech capabilities, users can efficiently compile lists of frequently purchased items using voice commands. This streamlined approach eliminates manual input barriers and fosters autonomy. Additionally, the function's innovation lies in the gesture-based retrieval of these lists – users can shake their mobile device to access their compiled lists instantly. This function is a pioneering step towards promoting independence and inclusivity in shopping for the visually impaired.

Integrating haptic feedback into the ShopEyes revolutionizes user interaction. This function provides tactile confirmation through vibrations for essential actions such as adding items to the instant shopping list. By catering to the sensory needs of visually impaired users, haptic feedback bridges the gap between digital interactions and tangible experiences. Real-time vibrations offer assurance and validate selections, significantly enhancing the user's confidence and reducing frustration. This inclusive design approach aligns seamlessly with the application's goal of empowering visually challenged individuals to navigate shopping environments independently.

I. ShopEyes Mobile Modules

Users of this mobile application can manage their shopping lists verbally. This implementation makes use of the more precise word recognition capabilities of React Native voice recognition technology. They can add things by voice command. Once the item has been added, a voice command saying that a specific product has been successfully added is given. When they purchase a specific item, it automatically removed from their shopping list. Additionally, the user has the option of removing any item from the shopping list. Users will be made aware of any unavailable items as they add items to the list. By doing this, the user is protected from unnecessary trips to the supermarket.

To obtain the necessary data for navigation utilizing web services, the mobile application establishes a connection with the back-end database. The items on the user's shopping list are located, and a path through the store to get to them all is found. When the shopping process begins, the user will be informed of the order in which the products will be browsed. People who are visually impaired keep a mind map of their surroundings that shows how many steps are involved and which way to turn. The term for this is cognitive mind maps. The human brain can form cognitive maps of a spatial environment, which can support wayfinding [9]. For example, the individual might recall taking ten steps forward, turning right, and then moving forward five steps to get to a

certain shelf from where they were. In considering this, the user is given navigational instructions that are detailed in terms of the steps they need to take, the turns they need to make, and the directions to each item.

With the use of barcode scanning, ShopEyes helps people who are visually impaired identify products. This process includes the following steps. When the customer reaches the shelf, the customer can tap the item in the app's cart. Then, it will open the camera to scan a product's barcode. By scanning the bar code, it can take the unit price and other details of the item. Then the user confirms the item, it will be automatically removed from the cart and added to the bill. After that, it will go to the next item in the list.

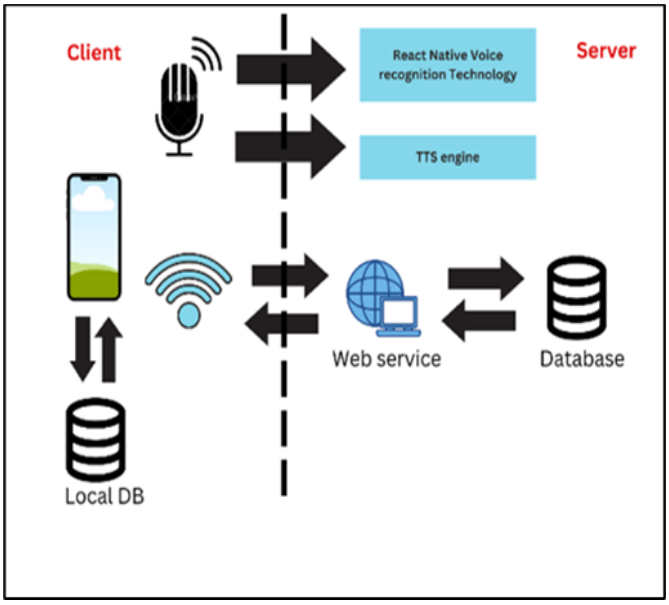

Fig. 2. Architecture of shopEyes.

Users can get equivalent products for a particular product based on their desire. One of the frequently used algorithms for determining associations between objects, the Apriori algorithm, is used in the analysis. The algorithm creates a list of products that were purchased along with a particular product using a data set of consumer purchases. The relevant web service for related products invokes a script written in R, a straightforward and efficient statistical programming language, and the Arules package, which implements the Apriori method [10]. The shop database is used to retrieve all the results, including information about the scanned item and equivalent products. This application produces these results by connecting to the web services and accessing the shop database. *Fig. 2* shows the fundamental architecture of the application.

By showing the item list, the app enables users to request assistance from shopkeepers when necessary. If the user needs the get assistance option, user can contact an assistant though a call by a voice command.

As shown in the Fig. 3, the interface of the application is straightforward and user-friendly. The button is conveniently placed in a central area for use. The user can respond to options by speaking to them by tapping the central button.

Fig. 3. ShopEyes mobile application interface.

II. ShopEyes Desktop Modules

The shopkeeper will use a web application that is part of ShopEyes. The two main modules in this web application are inventory management and navigation management. The shop keeper can update inventory records, add new items, and remove existing ones as necessary. The navigation management system enables supermarkets to provide up-to-date directions to a specific rack. The appropriate number of steps and directions are also stored in the database because the application uses step count to guide the user. As a result, the supermarket can now maintain an updated navigator menu. This web application's primary goal is to control the supermarket's inventory. The mobile application will use the shop database, which will contain the item information.

4. Results

The development and implementation of the application, an innovative mobile application designed to address the unique challenges faced by visually impaired individuals during grocery shopping, has yielded significant and transformative outcomes. That encompasses six major components: Shopping-Cart Management, Shop Management, Product Identification, Voice Navigation, Instant-Shopping and Haptic Feedbacks.

This mobile application empowers visually impaired users to create, manage, and organize their shopping cart with remarkable ease. Using voice commands or a simplified user interface, users can efficiently compile their lists. The application provides the flexibility to listen to and update their shopping cart, ensuring that they stay informed about their shopping needs.

Shop owners benefit from this system, as it offers a streamlined approach to handling stocks. Shop owners can view, update, and fulfill stocks, improving efficiency and reducing delays. Real-time availability status updates prevent unnecessary trips to the store, enhancing both customer and shop owner satisfaction.

Product identification is another advantageous feature in the app, which uses the device's camera and barcode scanner to instantly provide audio feedback about a product's attributes, prices, and other useful information. This empowers visually impaired users to make informed purchasing decisions independently.

This application provides an intuitive voice navigation menu that simplifies interactions within the application. With natural language prompts, users can seamlessly navigate sections, search for products, and manage their shopping cart. This voice-guided approach ensures that every step of the shopping process is accessible and inclusive.

ShopEyes introduces the innovative Instant Shopping List feature. Users can efficiently compile lists of frequently purchased items using voice commands. The unique gesture-based retrieval of these lists, by simply shaking the mobile device, promotes independence and inclusivity in the shopping experience.

This mobile application enhances user interaction through the integration of haptic feedback. This feature provides tactile confirmation through vibrations for essential actions like adding items to the instant shopping list. By catering to the sensory needs of visually impaired users, haptic feedback boosts user confidence and reduces frustration.

The decision to develop the solution as a mobile application has proven to be highly advantageous. Modern smartphones come equipped with accessibility features for users with visual impairments, making the app accessible to a wide audience. Moreover, the mobile application is user-friendly, easy to install, and cost-effective, eliminating the need for expensive and inconvenient external hardware devices.

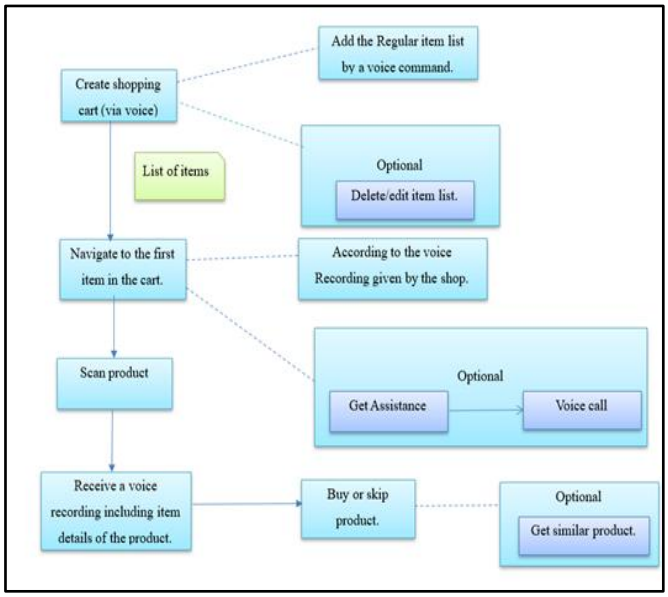

Fig. 4. Flow of the system.

These results represent a significant leap forward in addressing the challenges faced by visually impaired individuals when grocery shopping. This offers a comprehensive, user-centric solution that empowers users to shop independently, manage their shopping cart efficiently, and receive real-time assistance from shop owners. It impacts the shopping experience for those who are visually impaired, making it more comfortable, effective, and accessible.

5. Discussion

Our aim is to make grocery shopping easier for those who are visually impaired by developing a conventional shopping app. Many people can easily download and use this application because voice recognition and text-to-speech (TTS) are features that are available on all Android smartphones. It would be much easier to manage products and other management tasks with the aid of an inventory management web application, which would be extremely advantageous for the supermarket.

To utilize the system, visually impaired people do not need to acquire new navigational techniques and skills. The app makes use of a method known as cognitive mind maps. which visually impaired individuals use to navigate the app displays the number of steps needed to go to each location shelves, gathering the things they want. In comparison to managing their shopping cart on a website, users will have more flexibility with ShopEyes in a mobile application. Using the mobile application makes it simple to add or read items from the shopping list whenever necessary. To accomplish the system's goals, it was necessary to analyze the requirements, gather data, investigate existing technologies for implementation, get input from creative

authorities, and review relevant literature. By doing literature evaluations, it was possible to identify various approaches that were taken to solve the same issue. Most of the current, comparable systems do not provide a comprehensive solution to enable visually impaired people to go shopping on their own, it was found during the review of the literature.

All the mentioned problems have been resolved by the suggested system, which has produced a package that is interesting, affordable, and useful for both customers and store owners. The proposed system's accuracy level can be improved by utilizing the latest technological developments. As a result, the system may be developed in the future to make use of those technologies. This app is currently only available for Android and only in English. In a later project, the researchers want to adapt the program to other languages and make it available on iOS as well.

Refrences

[1] V. A. Kulyukin, J. Nicholson and D. Coster, "ShopTalk: Toward independent shopping by people with visual impairments," in *Proceedings of the 10th International ACM SIGACCESS Conference on Computers and Accessibility, ASSETS 2008*, Halifax, Nova Scotia, Canada, 2008.

[2] V. A. Kulyukin and A. Kutiyanawala, "Accessible Shopping Systems for Blind and Visually Impaired Individuals: Design Requirements and the State of the Art," *The Open Rehabilitation Journal*, vol. 3, no. 1, pp. 158-168, January 2010.

[3] S. Panchanathan, J. A. B. Jr, M. Rush and V. Iyer, "iCare - A user centric approach to the development of assistive devices for the blind and visually impaired," in *Tools with Artificial Intelligence, 2003. Proceedings. 15th IEEE International Conference on*, 2003.

[4] M. GILLEN, "TOOL: TapTapSee – Assistive Tech for the Blind and Visually Impaired," 4 March 2019.

[5] C. Murashima, "Be My Eyes: The popular app for the blind or visually impaired," 5 April 2023.

[6] L. Edwards, "Introducing Be My AI," [Online]. Available: https://www.bemyeyes.com/.

[7] "Shopiva - Grocery Shopping for the Visually Impaired," [Online]. Available: https://devpost.com/software/shopiva-grocery-shopping-for-the-visually-impaired.

[8] "How do people who are blind or visually impaired shop independently?," Sandy's View, 16 April 2015. [Online]. Available: https://sandysview1.wordpress.com/2015/04/16/how-do-people-who-are-blind-or-visually-impaired-shop-independently/.

[9] L. Ottink, M. Hoogendonk, C. F. Doeller, T. V. d. Geest and R. J. A. v. Wezel, "Cognitive map formation through haptic and visual exploration of tactile city-like maps," *Scientific Reports*, vol. 11, no. 1, p. 15254, July 2021.

[10] D. I. De Silva, M. R. A. Nashry, S. Varathalingam, R. Murugathas and T. K. Suriyawansa, "iShop — Shopping application for visually challenged," in *2017 9th International Conference on Knowledge and Smart Technology (KST)*, Chonburi, Thailand, 2017.