Android Shopping Assistant For Visually Challenged Person

S. Sikkandhar Rajaak[1], R. Boopalan[2],K. Akash[3], A. Vignesh[4], J. Jeyaprabhu[5]
[1, 2, 3, 4, 5] Dept of Computer Science and Business System
[1, 2, 3, 4, 5] Sethu Institute of Technology,
Pullor, Kariapatii-626115.

Abstract- *In the life of visually challenged people shopping is one of the greatest challenges. From getting around the supermarket to paying the bill at the cashier they need to rely on someone else. They never get a chance to shop on their own. Whether the person uses a cane, a seeing-eye dog or other sight tools, shopping is still a painstaking chore for them. This paper presents iShop - a complete mobile solution for the above mentioned problem of visually challenged people. iShop is developed in order to address the issues that the visually challenged people face while they do shopping and to provide a new, convenient shopping experience using modern technology.*

I. INTRODUCTION

Shopping has been always a serious challenge in the life of visually challenged people. Independent shopping is something that the visually challenged people have never experienced in their life. They always have to depend on their friends, relatives and shop assistants. When they do so they have to schedule their shopping upon the availability of their friends. Even if they go to the shop themselves they have to face some difficulties. Waiting for shop employees to assist them, difficulty in communicating with shop employees, unfriendly employees who get irritated with long searches and also being embarrassed to request certain items may become reasons for blind people to avoid getting help from shop employees. Due to these reasons they always like to go for shopping on their own.

For sighted people getting around a huge supermarket, locating the shelves of the desired product, getting the product from the shelf, identifying the product and comparing the products may not seem like a big deal. But these little things become real barriers for visually challenged people. These things make their shopping trip more of an inconvenience. Thus it was decided to provide a solution for this problem using modern technologies.

IShop is a mobile application developed to address the above mentioned problems in shopping for the visually challenged people. The main objective of iShop is to facilitate and enhance the shopping experience for the visually challenged people. The solution for this problem has resulted in a mobile application for several reasons. First of all, smart phones nowadays provide accessibility feature for the people with disabilities. So now people with visual impairments can also use mobile phones with the help “talkback” feature in Android. Another reason is, unlike previously proposed systems iShop doesn’t require any other external hardware equipment which are not suitable to carry around. All the functionalities of iShop are included in a simple mobile application where the user only needs to take his phone with him while going for shopping. Another main reason is that a mobile application is easy to install, easy to handle and is affordable by everyone since it doesn’t cost additional for bulky equipment.

Initially it was found that the visually challenged people struggle in two main areas in their shopping process. The first is getting around the super market to find where a product is located and the second is identifying the products and getting product information. IShop was developed taking these as fundamental requirements. Basically iShop contains six main modules which are: shopping list management, navigation, location-based promotions, product identification, getting instant help, inventory management, and supermarket plan customizer. In addition to this it also has some interesting features such as video calling a friend or family to get help, ability to check the availability of items in the store from home itself, get advertisements and available promotions in the store, and listening to total bill amount at any time in his shopping journey.

II. BACKGROUND OR LITERATURE REVIEW

Many projects have tried to provide a solution for the very same problem, but most of them were not able to address all the issues that the visually challenged people face while shopping. Moreover, most of them cost excessive amounts of money, which cannot be borne by these people. They also include hardware devices which are a burden to carry around and use.

Among those existing projects Trinetra, iCare, GroZi and shopTalk are some of the projects that are mentionable

[1], [5],[6],[7]. All the mentioned projects are carried out as research projects. TapTapSee and BeMyEyes are the only mobile applications available in the market[2],[3]. But they were able to satisfy only few of their shopping needs. iShop tends to overcome the limitations in the above mentioned projects and provide a better and complete package of solution. Table 1 shows a comparison between other similar products and iShop.

Table 1 : Comparison between iShop and similar systems

Comparison	Trinetra	ShopTalk	GroZi	iCare	TapTapSee	iShop
Indoor navigation & routing over voice commands	No	Yes	Yes	Yes	No	Yes
Location based optimal path recognition	No	No	No	No	No	Yes
Browse items and get item information	Yes	No	Yes	Yes	Yes	Yes
Manage shopping list	No	No	Yes	No	No	Yes
Interactive voice commands	Yes	Yes	Yes	Yes	No	Yes
Location based promotions	No	No	No	No	No	Yes
Functions without external hardware devices	No	No	No	No	Yes	Yes

III. METHODOLOGY

A list of functional and non-functional requirements was defined for the system in the beginning. These requirements were achieved by following modules of the system.

Shopping list management

This module allows the users to create a shopping list, add items to the list, delete items from the list and listen to the items in the list. Additionally it also let the users know the availability of the items added to the list from the home itself. This prevents the user from visiting a supermarket unnecessarily.

Navigation

This module first finds the shortest possible path to traverse the supermarket to get all items in the user's list using an algorithm to find most optimal path. Then the user will be provided with voice commands to reach each item. The directions will change spontaneously when the user reaches the location. The step counter sensor in the phone is used for this.

Location based promotions using Bluetooth beacons

This module provides an advanced feature which is listening to location based promotions using Bluetooth beacons. Since visually challenged people cannot identify advertisements and promotions available in the store, this feature takes a step ahead and makes it available for them as well. The list of promotions closer to the user's location will be available for them. For an example if the user is in the stationary department he will be able to listen to the offers/ promotions that belong to that department.

Product identification

This module of the application allows the user to identify the product by scanning the product using mobile phone camera. The module also tries to provide additional features such as getting similar products and comparing product with other products.

Get instant help

This feature helps the user to get instant help or assistance. An SMS notification is sent to the manager/responsible person of the supermarket with the location of the user in need of help, asking to send a shop assistant to him/her. The user can use the video call feature to video conference with his friend/family member and get their assistance if required.

Desktop application modules

The desktop application contains the inventory management modules with additional features such as reporting and notifications on low stock levels. The desktop application also contains the plan customizer module to manage the floor plan of the supermarket, the arrangement of shelves and its items, etc…

After entering the supermarket item, the purchasing process is carried out through two main cyclic phases. They are,

1. Narrating the direction and navigating the user to the location where the item can be found.
2. Identifying the product and getting details. Buying or skipping the product.
3. Optionally, listen to promotions in that department; get instant help or make video call.

The android mobile application interacts with the back end services to perform its functionalities such as getting product details, finding optimal path and retrieving item's locations, using web service as illustrated in the Figure 1. directions for navigation is specifically spoken to the user in terms number of steps to be taken and the turns and directions to each item.

Figure 1 : Application access database using web services

iShop mobile operates fully via voice. It follows a format where instructions are spoken to the user with the corresponding option numbers using TTS (text to speech engine) which is an inbuilt feature of android mobile. The user is required to speak the option number required. This user response is recognized using the Google voice recognition API, because it is more accurate and reliable. Then the logic is carried out accordingly.

iShop mobile modules

IShop mobile application enables the users to manage shopping list by voice. The Google voice recognition API is used for this implementation which is more accurate in recognizing words. They can add items by speaking. Once the item is added, voice command is given saying the particular product is added successfully. Once they buy a particular item it will be removed from the shopping list automatically. The items in the shopping list can also be removed whenever user wishes to. While adding items to the list, the users will be informed of unavailable products. This makes sure the user does not have to make an unnecessary trip to the supermarket. The mobile application connects to the back-end database to get required information for navigation using web services. The locations of the items in the user's shopping list are identified and the shortest possible path to traverse the supermarket to get all the items is found using the most optimal path finder algorithm. At the beginning of shopping, the user will be notified of the order in which items will be traversed. The travelling salesman algorithm is very complex to be used directly. Thus the travelling salesman algorithm's concept has been broken down into less complex components and used for the optimal path algorithm that was derived for this application. The algorithm that has been derived solves the problem of finding the shortest/most optimal path that has to be taken to visit all nodes (shelves), where distance between each shelf is the weight of the edge (path) between them. This algorithm has proved to be very accurate in producing the order in which each shelf has to be traversed.

Visually challenged people keep a mind map of their physical environment in terms of the number of steps and the turning directions. This is called cognitive mind maps [9]. For example, the person would remember walking 10 steps forward and turning right, then taking 5 steps forward to reach the dining table from the main door. Considering this, the Once the shelf order to travel is identified, the application finds the number of steps to be taken and the turns and directions to each item, and narrates to the user one by one. The application counts the steps of the user using the step counter sensor in the android mobile, and changes the directions spontaneously once the destination in reached. Once the user reaches the shelf, he will be given the shelf level in which the item is placed as well. The shelf level close to the ground is level one and the number increases as you go to the top.

The application provides location based promotions and advertisements to the user. Based on the department the user is in, the nearest beacon to the user in identified and the promotion data stored in that beacon is retrieved and narrated to the user through iShop application. To identify the nearest beacon, an algorithm is used. First the distance between each beacon connected to the mobile device is calculated using the RSSI values of each beacon Bluetooth signal. When the user enters a beacon's region, the app detects the beacon id closest to it and loads the data specific to that beacon. The user can listen to promotions and also choose to add the promotion items into their shopping list. Then the user's path will be refreshed. This enables advertisements and promotions to reach the visually challenged customer.

iShop uses barcode scanning to overcome the problem of visually challenged people in identifying the products. Every product's barcode location is stored in the shop database. Before the user starts scanning the product an

instruction is given to the user where the barcode can be found. iShop also provides additional features such as comparing products and getting similar products based on previous customer purchases. The application allows the user to compare the product with other available brands and sizes. iShop uses the concept of market basket analysis to get similar products for a particular product. The results of similar products are retrieved based on the analysis of previous purchase history. The analysis is performed using Apriori algorithm, one of the commonly used algorithms for identifying association between items. The algorithm takes a data set of customer purchases and produces a list of products that have been bought together with the specific product. The relevant web service of similar products invokes a script written in R which is a simple and effective statistical programming language and Arules package, which implements the Apriori algorithm. All the results including scanned item details, product comparison and similar products is retrieved from shop database. iShop application produces these results by connecting to the web services and accessing the shop database. Figure 2 shows the basic architecture of the application.

After identifying the product the iShop application provides several options including get similar product and compare product. Among them buying a product will add the product price to the total bill amount and go to the next item in the list and skipping the product will just go to the next item in the list. Then again the navigation module takes the user to desired location of the next item.

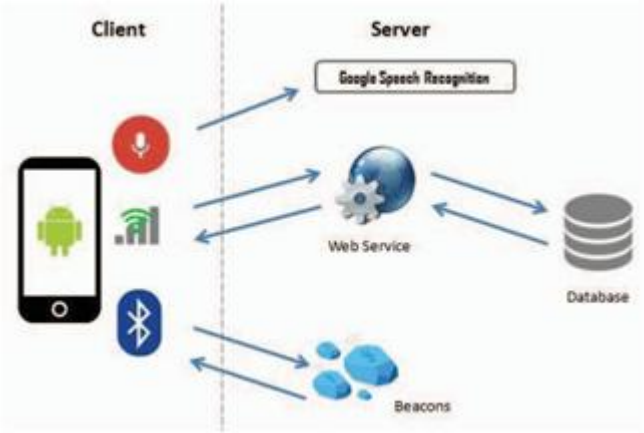

Figure 2 : Architecture of iShop

The app allows user to get assistance from the shop keepers if they need in case. If the user selects the get assistance option, it will send an SMS to the shop manager automatically through the app. The user can also make video calls to friends/family in order to get help. The video call takes place over the internet and so it will be of minimal cost.

The interface of the iShop application is simple and easy to use. The button is placed in a central location in order to be able to use using both hands. Tapping the central pink button will speak options for the user to respond.

Figure 3 : iShop interface

iShop desktop modules

iShop contains of a desktop application which will be used by the supermarket side. iShop desktop application mainly contains two modules that are Floor Map Management and Inventory Management. The floor map management allows the supermarkets to manage the arrangements of the items, shelves and departments. The user from supermarket side can add a new department, edit a department also remove a department. For each department the user will be able to add shelves as they need. When adding a shelf a user can customize the shelf with number of racks and the number of divisions for that shelf. Since the application uses step count for navigating the user, the relevant number of step count also stored while adding a shelf. So now the supermarket can keep track of the number of shelves in a particular department. And also will be able to manage which shelf belongs to which department. Once the shelf is allocated for a department, the items that belong to that department can be arranged in that shelf. The shelf is represented by a table in the desktop application. The rows represent the racks and the columns represent the divisions. Storing an item in the cell (3,4) means that the items is located in 3rd rack from the bottom and 4th division from left to right.

The main intention of iShop desktop application is to customize the map of the supermarket. iShop mobile application can be used by the visually impaired users for any supermarket after customizing it's map using the desktop application. The arrangement of the items will be stored in the shop database and that will be used by the mobile application especially in the navigation module.

IV. RESULTS

This mobile application is more user-friendly because the user does not need to read shopping list one by one after he/she starts shopping. So it reduces the time they spend in shopping. To successfully identify the user's position (indoor) the researchers came up with an algorithm which does Beacon triangulation using RSSI value provided by beacons according to the distance of the beacon and the phone. According to calculations 5 RSSI difference approximately makes a difference of 12-15cm.However RSSI values are subjected to environmental interferences therefore high accuracy can be obtained where there are less environmental inferences. The closest beacon's id is detected to retrieve location-based promotions.

The barcode location is specified according to its position in the item when the phone is placed approximately one hands length from the item. The barcode location will be described to the user in detail before starting barcode scanner. This way the user is able to identify the barcode easily.

The system was successfully tested at a supermarket. When testing, the beacons were placed on the ceiling to avoid interferences. Initially all the common features including list management, navigation, location-based promotions, get instant help and video calling, product identification and comparison and all the features of the app were successfully tested using an android 6.0.1 version phone and with a blindfolded user. The next step of evaluation of the system was done with a visually challenged user at the same environment. The testing included 4 items in the list. In the supermarket the user was able to successfully navigate to the locations with an accuracy level of 90%. During the navigation, step count of visually challenged user had a variance of 1-2 steps. After reaching the right location the user was able to identify all the products in the list and retrieve related information by scanning the product. The user was able to listen to the total bill amount every time after purchasing a product and it was resulted with 100% accuracy. Finally the user was able to finish his shopping journey successfully with just a mobile phone using iShop application alone.

The system was finally evaluated with five visually challenged users who were able to complete their tasks and finish their shopping. This was resulted in satisfactory level of 95%.

Even though several other projects were developed to overcome this problem, they were able to fulfill a few requirements only. iShop application provides a complete packaged solution which can be used just with the user's mobile phone. Unlike other projects iShop doesn't require expensive tools such as RFID reader, Barcode reader, Baracoda pencil. iShop also relieves the user from carrying bulky equipment while shopping. The researchers of the project has been successful in producing a product which can be used by visually challenged shoppers, shop owners and shopping mall managers to get their regular day to day tasks done in an easier and a cheaper way.

After entering into the supermarket the app navigates the user from the entrance to the shelves using the shortest path identified using the optimized short listed items and the floor map. The step counts and directions are given as the instructions for navigation. The users can get information about the promotions available in the supermarket .The user can get information about the promotions different departments. The app uses beacons, a Bluetooth transmitting device which is used to identify department they are standing and gives the details of the promotions available in that department.

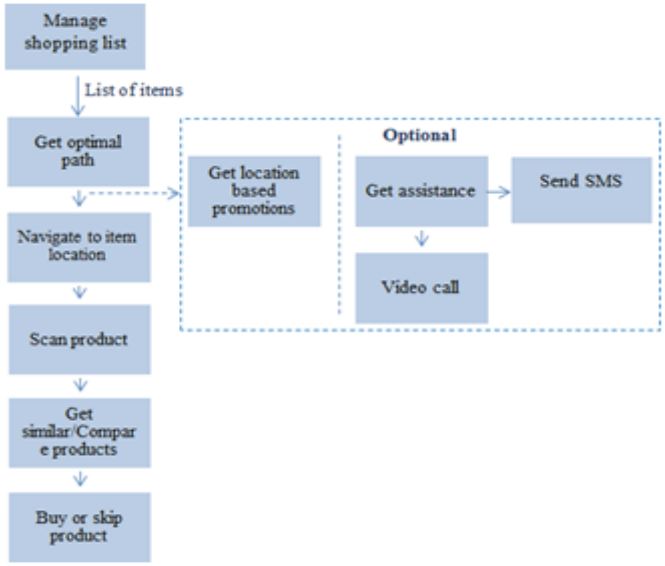

Figure 4 : Flow of the system

The IShop also has a desktop application which facilitates the supermarket administrators to manage inventory and the floor map. The floor map management is a logical implementation of how shelves and items are arranged in each shelves and the step counts between each divisions in shelves is stored as well.

V. CONCLUSION

Our intention is to provide a more conventional application for the visually challenged people which can make

their shopping more easily in a supermarket. The Google voice and text to speech (TTS) is available in all android mobiles so many people can easily download and use the iShop application. Inventory management desktop application would make it possible to deliver dynamic information about prices, size, brand, barcode details etc which would benefit the supermarket immensely.

IShop takes an advantage of both navigation skills that people use in their everyday lives and the inventory infrastructure already present in many grocery stores. To use the system the visually challenged do not have to learn new set of navigation skills. The app uses a technique called cognitive mind maps which is used by the visually challenged people to navigate around places, i.e. the app gives step counts to reach each shelves and collect items they want. IShop handles many tasks with the use of a mobile phone. It will be more flexible for the users to manage shopping list in mobile application than in a website. Items in the shopping list can be added or read whenever needed easily by using IShop mobile application.

Analyzing the requirements, collecting the data, studying existing technologies to implement the system, gathering ideas from resourceful authorities and conducting literature reviews were done in order to achieve the objectives of the system. By conducting literature reviews different methodologies that were used to address the same problem was found. During the literature survey it was found that most of existing similar systems do not provide the complete solution to enable visually challenged users to shop alone. They do not provide any option regarding available items where shoppers can check at home, and find the most optimal path for traversing the store which are unique to iShop. Moreover iShop provides all features required to help the user shop independently all in one package.

The proposed research system have overcome all of the obstacles mentioned above and have implemented an interactive, less costly and an efficient package to shoppers and shop owners.

Accuracy level of the proposed system can be increased by using latest technologies of the future. Thus, in the future the system can be developed in a way to utilize those technologies. iShop is now only available for Android and that also in English language only. As a future work, the researchers intend to make the app available in iOS as well, and also to customize the app into many different languages.

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