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ANDROID-BASED WALKING ASSISTANT FOR BLIND AND LOW-VISION PEOPLE SUGGESTING THE SHORTEST PATH USING FLOYD-WARSHALL ALGORITHM

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ABSTRACT

Sohrawordi M, Hossen MM, Uddin MP, Nitu AM, Islam MR (2015) Android-based walking assistant for blind and low-vision people suggesting the shortest path using Floyd-Warshall algorithm. *J. Innov. Dev. Strategy.* 9(2), 62-69.

In our society, several supports are required for the physically disabled person. One of the supports is the guarantee of mobility for the blind and low-vision people. There are many efforts but even now, it is not so easy for the blind people to independently move anywhere. In this paper, a navigation scheme has been proposed and materialized for the blind and low-vision people in order to provide precise location information using Android-base smart phone with a view to move freely. The navigation scheme uses TTS (Text-to-Speech) for blindness in order to offer a navigation service through voice and Floyd-Warshall algorithm for suggesting the shortest paths. Also, it uses Google map API to show the route information. The proposed scheme, as an independent program, is fairly cheap and it is possible to install onto Android-based smart phone in an easy manner. This allows blind and low-vision people to access the program interactively. The performance of the application has been tested through Android 4.2.1 based Samsung Galaxy mobile phone. As the result the voice-support about the map information has advanced favorably.

Key words: *Blind and low-vision People, TTS, visually impaired persons, navigation system, Floyd-Warshall algorithm, shortest paths*

INTRODUCTION

In the society, a lot of people are physically disabled such as the blind and low-vision people. The statistics of World Health Organization in 2014 shows that there are 285 billion people in the world with visual impairment, 39 billion are blind and 246 million have low vision (WHO 2014). It's urgent to provide the guarantee of mobility for the blind and low-vision people to move freely. Increasing mobility, safety and independence for the visually impaired is of one of the significant importance and frequent research topic. On the other hand, with the rapid development of the mobile technologies, a smartphone might be the new assistant for the visually impaired people. Consequently, the development has made the devices small, portable, fast and equipped with different sensors. Additionally, the development of the cellular network has made the devices permanently connected to the internet at a sufficient speed to download requested data on demand. All of these technologies provide a handy help for everyone including the disabled and visually impaired people. Now-a-days, GPS technology is increasingly used for navigation and location determination as well. People from many industries are using GPS in such a way that makes their work more productive, safety and often easier (TNL 2007). In this paper, a research of a navigation system for blind people is proposed in order to provide more precise location information. To identify the position and orientation and location for the blind person GPS technology has been used. The application suggested in this paper uses TTS program and Google Maps APIs in order to provide navigation using voices. Suggested system uses Android-based smart phone which is less tiring to use and it is fairly cheap and provides an easier mobility. Additionally, the system can help to determine exactly where a person is at any given moment. Not only it can speak the name of the required street for the blind and low-vision people, but also give the exact latitude and longitude of where the object is located. It can also give the step-by-step directions to a new destination from the current location. The directions are also often automatically recalculated if the user makes a wrong turn or decide to take a detour along the way, so the user never gets lost. A confirmation voice message is sent to the user when he/she reaches the destination so that he/she can easily understand about the destination place. Moreover, the shortest path to the destination is suggested using Floyd-Warshall algorithm.

RELATED WORKS

There are several efforts for the guidance of moving for the blind and low vision people. Several mobility aids for the blind exist, although the blind cane is lightweight, cheap, and relatively sturdy, making it by far the most widely used. Artificial vision is the most important part of human physiology as 83% of information human being gets from the environment is via sight (Kumar and Usha, 2013). As electronic technologies have been improved, a research about Electrical Aided: EA for blind people has started. With a current product, Human Tech of Japan developed Navigation for blind people, using GPS and cell phone (Cha *et al*. 2013). The oldest and traditional mobility aids for persons with visual impairments are the walking cane (also called white cane or stick) and guide dogs. The drawbacks of these aids are range of motion and very little information conveyed. With the rapid advances of modern technology, both in hardware and software have brought potential to provide intelligent navigation capabilities. Recently there has been a lot of Electronic Travel Aids (ETA) designed and devised to help the blind people to navigate safely and independently (Dambhare and Sakhare, 2011). (Kang *et al*. 2011) proposed a machine-machine intelligent walking assistant for the blind and low vision people. Using

GPS an implementation of a location based service (LBS) for various sizes of maps has been discussed in (Bae *et al.* 2010). (Broll *et al.* 2009) proposed an improved mechanism for the accessibility of NFC/RFID-based mobile interaction through learnability and guidance. A prototype through Android-based mobile devices for the investigation of interaction with blind users has been proposed by (Chiti and Leporini, 2012). (Markus *et al.* 2012) proposed an Android-based scheme of accessibility for the blind and named mobile slate talker (MOST). An Android based model with voice recognition capability for inputting smear test result has been discussed by (Paul and George, 2013).

PROPOSED SYSTEM

In every moment the visually impaired people face many problems. Again, to keep orientation in an outdoor (city) environment is also a remarkable problem. Especially, when blind people are located in an unfamiliar environment, the orientation becomes almost impossible. Basic orientation is only in a starting phase, but people might want to discover places and services located nearby. Normally, for visually impaired people, there is not any option to receive information about such places. They have to ask others for help and thus they become dependent on others. With the current improvement of mobile technologies, a mobile device with internet connection might address some of these problems. A smartphone mobile device can become the first guide the visually impaired people. Using this guide in his/her pocket, the user becomes more independent. The system proposed in this paper focuses on an Android-based smartphone application which will provide the user about the useful categorized information about his/her surroundings in an outdoor environment (cities). The provided information will contain points of interest (POI) and other remarks located in neighboring streets. The system will assist the users in gaining an idea of places available in the surrounding area, as well as to obtain the directions to a specific destination using Floyd-Warshall algorithm. The data and functions provided by the system will address one of the biggest problems of visually impaired people. The main features of the proposed system are:

- The application takes the destination address through voice.
- It periodically updates the status bar that tells the user the addresses of nearby locations retrieved from the GPS.
- It has a built-in compass that will always point to the right direction.
- It has the ability to directly launch the maps navigation in walking direction mode.
- For convenience, the application provides a list of favorite places for faster access.
- It also introduces a concept of accessible tactile map that enables a user to search for places on the touchscreen.
- If the user gets lost, the application will automatically vibrate and tell the user that he/she is going the wrong way. This interaction is made accessible using the text-to-speech (TTS) synthesis.
- It sets up proximity alerts based on location.

Due to the fact that this system is designed for visually impaired users, there are many specific requirements on the application. The problems are both on the input and output sides of the interaction. Since the user cannot see the controls that the application provides on the screen, he/she is limited only to hardware keys, standard gestures or voice commands as inputs. On the output side, the application needs to present the results of the commands, as well as other information, to the user in a different way than just on the screen. Therefore, the output of the application will be focused on voice, using speech synthesis.

The main requirements related to the specific human-computer interaction involved in this system are:

- Controls and menus are organized in a simple list for easy navigation.
- Application includes voice input capability to give voice commands.
- Application verbally communicates to the user, presenting the information on the screen.

Besides the human-computer interaction requirements, there are also specific requirements related to the data provided by the application. The application needs to focus on needs of visually impaired people and provide useful data for the destination.

A. System Design

The walking assistant system is a real life problem-solving application. The user section is designed in such a way that the user will enjoy the facilities of the application.

1. Modular Diagram

The modular diagram of the system is shown in Figure 1.

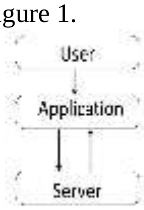

Fig. 1. Module diagram

2. Use-case Diagram

The use-case diagram of the system is shown in Figure 2.

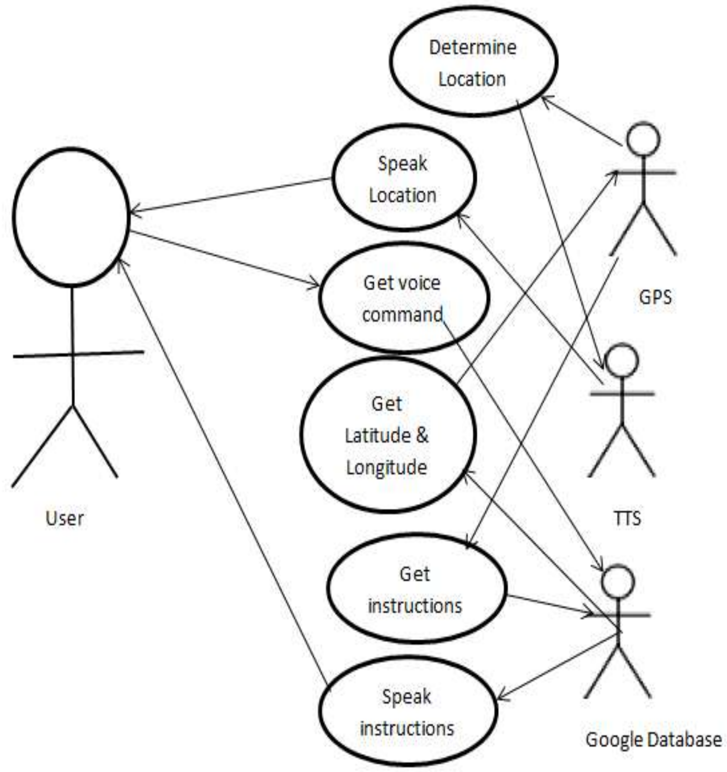

Fig. 2. Use-case diagram

3. Data Flow Diagram (DFD)

The 0-level DFD of the system is shown in Figure 3.

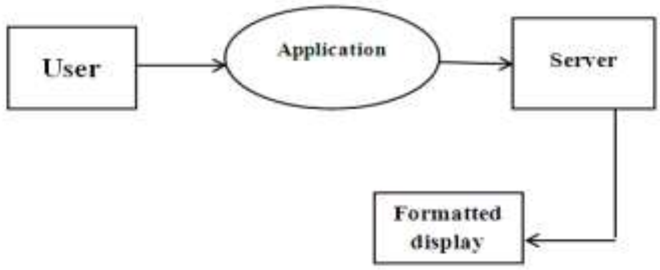

Fig. 3. 0-level DFD

The 1-level DFD of the system is shown in Figure 4.

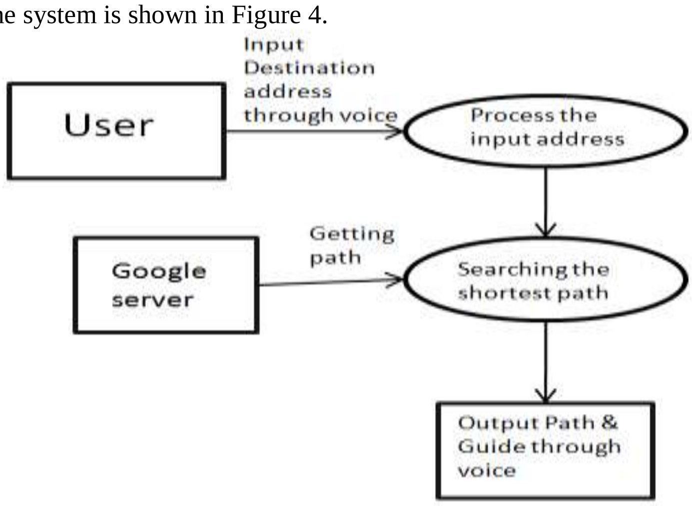

Fig. 4. 1-level DFD

4. State Diagram

The state diagram of the system is shown in Figure 5.

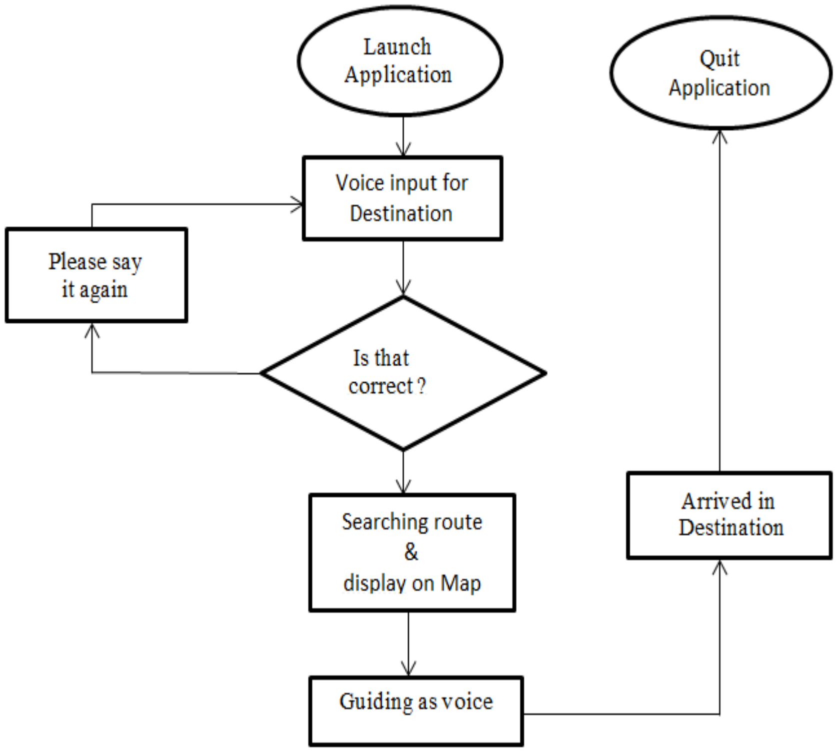

Fig. 5. State diagram

5. Sequence Diagram

The sequence diagram of the system is shown in Figure 6.

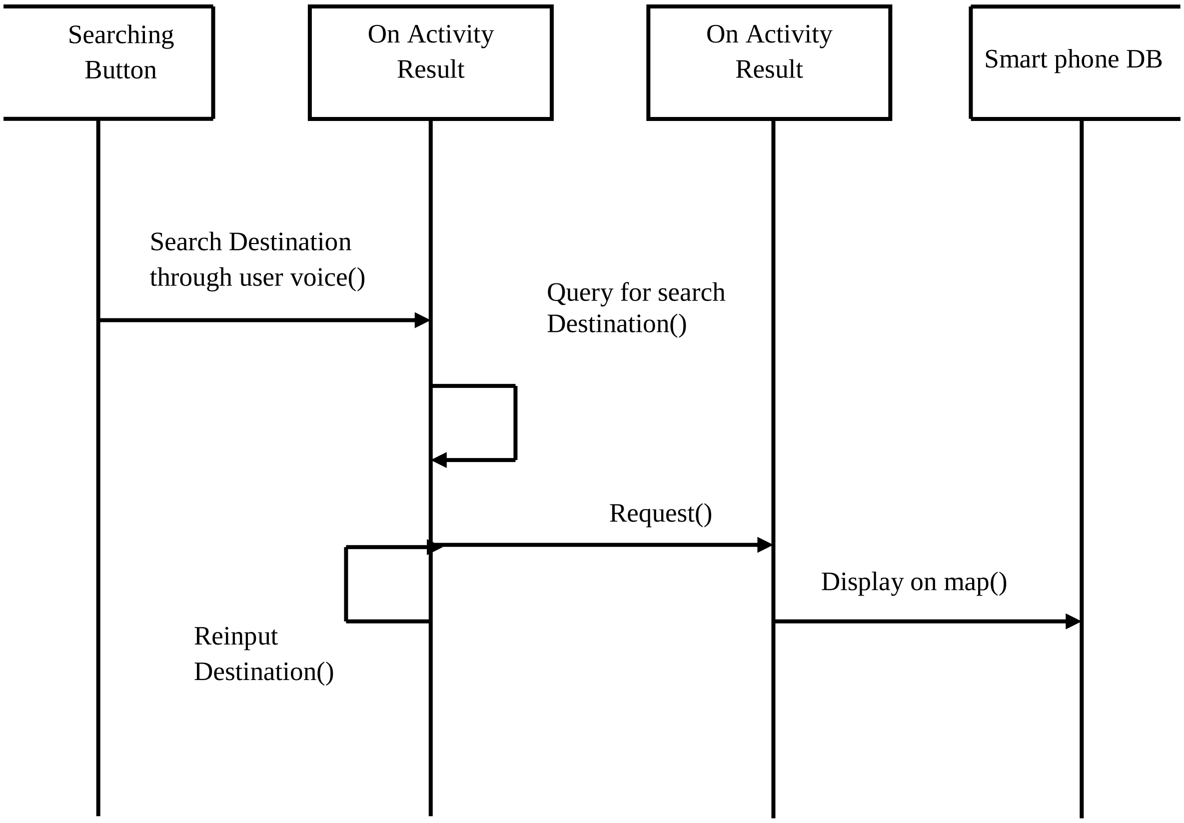

Fig. 6. Sequence diagram

B. Implementation

The tools and technologies used for the development of the proposed application are Android operating system**,** Java programming language, Java platform, Global positioning system, Google maps, LBS-location-based system etc. Additionally, Floyd-Warshall algorithm, a dynamic programming algorithm, has been applied to suggest out the shortest path from the source to the destinations. The main parts of the implementation are the data providers, location and orientation, voice input and output. These are discussed below.

1. Data Providers

These parts describe the techniques and methods that retrieve the information about the places of interest that are afterwards presented to the user. There are several data providers used throughout the implementation of the application that provide different information.

Google Maps

The main data provider available for the Android platform is the Google Maps API. The implemented application retrieves data from the Google Maps in several ways. The application uses a MapActivity class provided by the Google Maps library. This activity provides view of the map that uses the Internet connection to display maps retrieved from Google servers. The application uses the MapView to show the current location on the map and also rotates the map so that it is oriented according to the reality, not fixed with the north up. The application also connects to the Google Maps data API to receive walking directions from the device current location to a specific POI. The received data provides the application with the street distance and turn-by-turn navigation. The route is only used to determine the number of turns.

OpenStreetMap (OSM)

The main resource of the POI is the OpenStreetMap project with associated API. We focused on several tags and keys related to POIs. Among other keys, the application retrieves railway, amenity, office and shop. In order to obtain those specific points, rather than the whole map including all streets, buildings, etc., the application queries the map. To query a map, the application calls a script developed as part of the OpenStreetMap project.

2. Location and Orientation

The most important sensors that serve as input information for the application are the location and orientation sensors of the device. The application uses two types of sensors-GPS (or network) to determine the location and a compass to determine the orientation.

3. Compass

The usage of the compass sensor is fairly similar to the location sensors. A class that wants to receive compass updates needs to implement CompassSensorListener interface and register itself by the SensorManager. There are two methods to be implemented by a CompassSensorListener. The more important one, onSensorChanged (SensorEvent event), gets updated upon a change of values of the specified sensor. The event parameter carries an array of oat numbers. The size and contents of the array depends on the specified sensor type. In case of the compass sensor, only the first value is relevant and represents the azimuth to the magnetic north. When used with other sensors, the array contains values describing the orientation of the device in all axes or values representing acceleration in all axes.

4. Walking Directions

The application uses data provided from the Google Maps API at maps.google.com to retrieve turn-by-turn walking directions. There are functions regarding getting directions that are available through HTTP request with defined parameters. The application requests walking directions and parses the returned result to determine the walking distance and also the number of turns. The important tags in this XML response are the placemarks. Each <placemark> tag describes a point of the route where the route turns and continues on a different street. The last placemark tag is different. Inits <description> tag, it contains the distance and estimated walking time. Additionally, it includes coordinates of all points along the route in <coordinates>. The application extracts only several information from this response. Based on the number of placemarks, it evaluates the number of turns along the route, which informs the user about the complexity of the route. Other information extracted is the total length of the route. When obtained, this information replaces the original air distance that is used initially for approximate sorting of the places. Because the process of retrieving the walking directions is time consuming, it is not possible to load the route for all the items available. Therefore, the list of places displays only several items with the walking route evaluated and others are evaluated and displayed on demand. There is a “load more” button at the end of the list that starts the ListLoaderTaskthat reads the walking route of the next available places.

5. Voice Input

The voice input is performed by calling the voice recognizer intent available in the API .To start the RecognizerIntent.ACTION RECOGNIZE SPEECH the components in the application menus have SpeakLongClickListener class assigned as the OnLongClickListener. The code sets up the intent to recognize words in style of web-search keywords (refer to paammeter EXTRA LANGUAGE MODEL and its value of

LANGUAGE MODEL WEB SEARCH) and defines English as the language of the recognition. Upon the start of the intent the code also defines the REQUEST CODE that is being passed to the onActivityResult() method of the parentactivity in order to recognize which intent just finished its run. In onActivityResult() method the parent activity receives the recognized words in a form of ArrayList<String>.

6. Voice Output

The application relies on the voice feedback generated by the TalkBack accessibility service. There is an option of implementing a custom one by extending the AccessibilityServiceclass. This option was tested but it is not currently in use because the TalkBack service provides better feedback, especially for dialogs or options menus. The accessibility event with a type of AccessibilityEvent. TYPE VIEW FOCUSED is the most important one for the application.

C. Testing

The system is tested for various inputs. Some snapshots of the walking assistant are shown below.

Fig. 7. Beginning screen

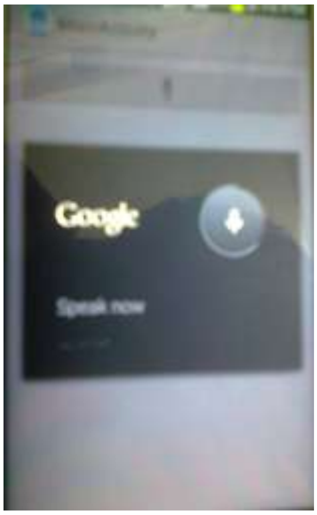

Fig. 8. Voice input screen

Fig. 9. Destination searching screen

Fig. 10. Voice navigation screen

D. System Development Requirements

As the walking assistant is based on usage of two devices, we have divided the system requirements into two parts. These are categorized as hardware requirements and software requirements. The hardware includes processor, RAM, disk space etc. and software incudes operating system such as Windows–XP, Windows–7, Linux or others. These are summarized in the following table.

Table 1. Project development requirement

Devices	A personal computer		Android Virtual Device
Hardware requirements	Processor	Pentium IV or higher	Android Virtual Device can be configured with Eclipse IDE. Need to have Android OS Google API version 4.0 or higher support.
	RAM	128 MB or higher	
	Disk space	128 MB	
Software requirements	Operating system	Windows–XP, Windows–7, Linux or any other OS	

E. Application User Requirements

To use the developed application the user needs an Android OS-based smartphone with version 4.0 or higher, Internet connectivity and GPS support.

RESULT AND DISCUSSION

There are two buttons in the walking assistant application i.e., ‘favourite’ and ‘search’ buttons. In order to provide search service user needs to push the ‘search’ button and to save the destination user needs to push the ‘favourite’ button for future reference. Figure 7 shows the beginning screen of the program. When user pushes the ‘search’ button, it shows the screen for users to say the destination as shown in figure 8 and the user says the destination. After getting the required destination with confirmation (by saying yes by the user), the application notifies the user by a screen that says searching and voice-alarm saying it will search for the destination. Figure 9 shows the screen of finding the destination. After the search has been finished, it marks the shortest route using Floyd-Warshall algorithm from the position of the user to the destination on maps saved in smart phone DB. When the destination was incorrectly said or accepted, the message saying, “no matching data” comes up on the screen, and the user simply pushes ‘speak again’ button to say the destination correctly. After the route has been completely shown on the map, the application can guide the user after the user has pressed the setting button on the device. Figure 10 shows the voice navigation screen.

CONCLUSION

Considering the trouble of the visually impaired people, we have proposed the design and implementation of the smartphone-based application using GPS that will help the blind and visually impaired people to navigate in a new environment. Specially, it tries to help the blind people to become more independent in a city environment. The walking assistant, as an independent program, is fairly cheap and it is easily possible to install onto the smart phones held by the blind people. The developed service uses smart phones in order to search the route between the current location of user and the destination to provide a voice-navigation. The performance of the application was tested using Android 4.2.1 based Samsung Galaxy mobile phone. As the result, voice-support about the route was successfully proven to work without any troubles. The navigation system uses TTS (Text-to-Speech) for blindness in order to provide a navigation service through voice. Also, it uses Google map API to apply map information. This system has successfully tested with visually impaired users and is ready to be deployed on the Android market. However, the proposed system can be extended to help the blind people with obstacle detection mechanisms. These obstacle detection modules can be coupled with the Android application to notify the user when he/she encounters an obstacle in his path.

REFERENCES

Bae JS, Park DW, Sohn YH (2010) Implementation of Location Based Service (LBS) using GPS for Various Sizes of Maps. *Korean Institute of Information Technology*, 8(4), 19-24.

Broll G, Keck S, Holleis P, Butz A (2009) Improving the Accessibility of NFC/RFID-based Mobile Interaction through Learnability and Guidance. 11th *International Conference on Human-Computer Interaction with mobile devices and services*, USA.

Cha JS, Lim DK, Shin Y (2013) Design and Implementation of a Voice Based Navigation for Visually Impaired Persons. *International Journal of Bio-Science and Bio-Technology*, 5(3), 61-68.

Chiti S, Leporini B (2012) Accessibility of Android-Based Mobile Devices: A Prototype to Investigation Interaction with Blind Users. Lecture Notes in Computer Science. Vol. 7383.

Dambhare S, Sakhare A (2011) Smart stick for Blind: Obstacle Detection, Artificial vision and Real-time assistance via GPS. *2nd National Conference on Information and Communication Technology (NCICT)*, India.

Kang C, Jo H, Kim B (2011) A Machine-to-Machine based Intelligent Walking Assistance System for Visually Impaired Person. *The Journal of KICS*, 36(3), 195-304.

Kumar MN, Usha K (2013) Voice Based Guidance and Location Indication System for the Blind Using GSM, GPS and Optical Device Indicator. *International Journal of Engineering Trends and Technology (IJETT).* 4(7), 3083-3085.

Markus N, Malik S, Juhasz Z, Arato A (2012) Accessibility for the Blind on an Open-Source Mobile Platform: Mobile Slate Talker (MOST) for Android. Lecture Notes in Computer Science, Vol. 7383.

Paul TT, George S (2013) Voice recognition based secure android model for inputting smear test result. *International Journal of Engineering Sciences & Emerging Technologies*. 6(3), 344-351.

Trimble Navigation Limited (2007) GPS: The First Global Navigation Satellite System. Sunnyvale, California, USA. Obtained from the webpage (http://www.saveourgps.org/pdf/GPS-The-First-Global-Satellite-Navigation-System-by-Trimble.pdf).

World Health Organization (2014) Visual impairment and blindness, Fact Sheet N-282. Obtained from the webpage (http://www.who.int/mediacentre/factsheets/fs282/en/).