Voice Operated Guidance Based GPS Systems for Vision Impaired People with Ultrasonic Obstacle Avoidance

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Abstract: **Navigation device for the blind people focus on travelling from one location to another. They are avail with navigation stick which provides obstacle detection. The other novel features of the navigation stick are staircase detection and no formal distance scaling scheme. It also provides information about the floor status. It consists of low power embedded system with ultrasonic sensor and safety indicators. While in navigation mode the stick reaches the destination by avoiding obstacles using ultrasonic and infrared sensor inputs.This project investigated the suitability of a user centred client server approach for the development of a talking GPS system intended to fill a niche for outdoor way-finding. The work resulted in a working prototype proof-of-concept system that uses a speech-recognition speech-synthesis interface. The prototype solution includes a custom web application which accesses the Google maps API. The system is intended to be scalable and extensible with additional features such as sensors for obstacle avoidance and access to web-based information such as weather, train or bus timetable information. The client server approach was found to be suitable for the development of this type of application.**

Keyword:RFID, GSM, GPS, speech recognition, client server, Ultra Sonic Sensor, blind, impaired vision, way-finding, guidance, navigation,IR Sensor and Accelerometer.

I.INTRODUCTION

The World Health Organisation estimates there are about 314 million vision impaired people in the world, of which about 45 million are blind **[1]**. The leading causes of blindness are cataract, uncorrected refractive errors, glaucoma, and macular degeneration. Many people who are seriously vision impaired use a white cane and/or a guide dog to avoid obstacles. Recent years have seen the development of several technologies designed to assist vision impaired people, both for obstacle avoidance, and to travel to specific locations, or way-finding. The blind traveller should depend on any other guide like blind cane, people information, trained dogs, etc. Visual function can be classified by four tiers: normal vision, moderate visual impairment, severe impairment, and complete blindness. Legally blind refers to a person who has less than 20/200 vision in either eye, or a limited field of vision. Many virtually impaired people use walking sticks and guide dogs to move from place to place. For this group of population; the goal is often to complete tasks in the least obstructive method. A guide dog is trained to guide its users to avoid the accidents from objects and barriers. When a visually impaired person is using a walking stick, they waving their walking stick and finds the obstacle by striking obstacles ahead of them.

II.LITERATURE SURVEY

Blind and visually impaired people are at a disadvantage when they travel because they do not receive enough information about their location and orientation with respect to traffic and obstacles on the way and things that can easily be seen by people without visual disabilities. The conventional ways of guide dog and long can only help to avoid obstacles, not to know what they are. Navigation systems usually consist of three parts to help people travel with a greater degree of psychological comfort and independence. Sensing the immediate environment for obstacles and hazards,providing information about location and orientation during travel. Today in the market different technologies like GPS, GPRS, etc. are used to navigate visually impaired people. The studies of various published international papers have been done. Before more technologically advanced solutions to mobility aids are discussed it is useful to outline basic properties of the traditionally used primary aids and explain their main properties and limitations.

1) White can: The most popular mobility hand held aid. It is usually foldable and adjustable to the height of the user. A blind person using swing-like movements, "scan" the path in front in approx. 1 m distance (near -space protection).The cane requires about 100 hours of training for skilful use, e.g. detecting drop-offs, walking up and down the stairs.

Advantages: cheap, light-weight constructions available, effectively informs of shorelines, landmarks and obstacles at ground-level, notifies others about visual disability of its user. Disadvantages: does not protect from obstacles at torso and face level.

2) Guidance of dog: A specially trained dog assisting the blind in obstacle avoidance, but usually not aiding in way finding (unless travelling a familiar path), e.g. the dog is trained to stop before obstacles, reacts to commands on walking directions. In spite of their great usefulness, guide dogs are a rarely used aid - only about 1% of the visually impaired use it. Most guide dog owners do not simultaneously use the dog and the white cane. Advantages: good in following familiar paths, good overall obstacle avoidance, trained for selective disobedience when sensing danger to his owner. Disadvantages: very costly (training cost approx. $40k in the USA), guide dog service period is on average 6 years, regular dog up-keeping costs and lifestyle changes.

3) HUMAN GUIDE: A blind person walks hand in hand with a sighted guide. Advantages/disadvantages: The most obvious, but in practice not a permanent solution for aiding the blind in mobility and navigation. A blind person lacks privacy and can have a feeling of being a burden to his or her guide.

III.RELATED WORKS

Blind and visually impaired people are at a disadvantage when they travel because they do not receive enough information about their location and orientation with respect to traffic and obstacles on the way and things that can easily be seen by people without visual disabilities. The conventional ways of guide dog and long can only help to avoid obstacles, not to know what they are. Navigation systems usually consist of three parts to help people travel with a greater degree of psychological comfort and independence: sensing the immediate environment for obstacles and hazards, providing information about location and orientation during travel and providing optimal routes towards the desired destination. Sunita Ram and Jennie Sharf designed the "People sensor," which uses pyro-electric and ultrasound sensors to locate and differentiate between animate (human) and inanimate (non-human) obstructions in the detection path. Thus, it reduces the possibility of embarrassment by helping the user avoid inadvertent cane contact with other pedestrians. The system also measures the distance between the user and obstacles. John Zelek's**[2]** work on a technology, "the logical extension of the walking cane," which provides visually impaired individuals with tactile feedback about their immediate environment. Two small, webcam-sized video cameras wired to a portable computer feed information into a special glove worn by the user. The glove has vibrating buzzers sewn into each finger that send impulses to the user warning of terrain fluctuations up to 30 feet ahead. One major limitation of these systems discussed so far is that they merely deal with navigation service in outdoor or indoor but not in the actual combined traveling environment. Imagine a visually impaired person needs to travel from his home to his office. He has to use at least two systems to guide him while walking indoors and traveling outdoors. His life will be much easier if one single system could guide him all the way to the destination. C.A.D.V.I is such a kind of integrated navigation system that the user can employ while traveling from an outdoor environment to an indoor environment or vice versa.

IV.METHODOLOGY

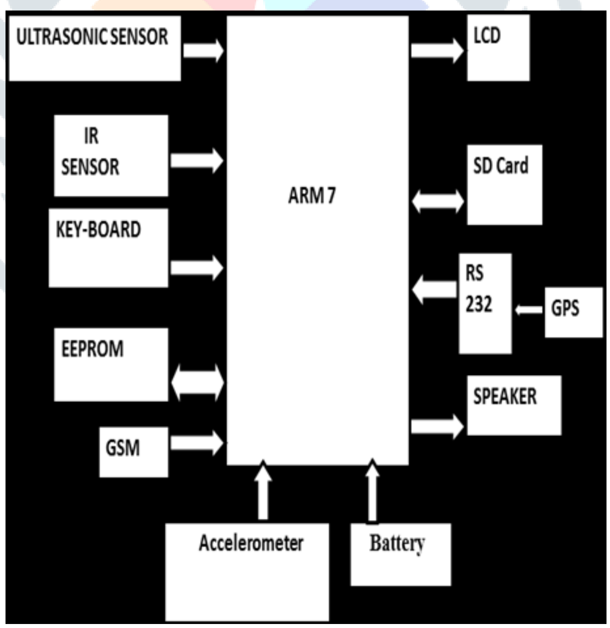

Figure1: Block Diagram.

The Figure 1 shows the block diagram of the walking stick unit that is present in the walking stick of the blind people. In this paper, the main objective is GPS and GSM section, obstacle unit (IR SENSOR AND ULTRASONIC SENSOR). The blind person will reach his destination place using voice recognition. He will speak his starting and destination place. All this detail will be displayed on LCD. When he wishes to go to any new location he will enter the position using keyboard. His location will be trace using GPS. The co-ordinates given by GPS are stored in EEPROM. And it is given to micro-controller. It will match the co-ordinates and then it will display on LCD and announcement will be done on speaker. Accelerometer is fitted on the stick, thus blind person turn to any direction such as left, right, forward and backward. So he will come to know the location of that place he is facing too. RFID will be placed at every corner. So as to know the position of the blind person standing, Ultrasonic sensor and IR sensor is used to detect the obstacle such as vehicles, any person etc. As soon as obstacle is detected the blind person is warned with the help of speaker, thus avoiding any kind of mishap.

V.SYSTEM ANALYSIS

Speech Recognition (Client): allows the user to interact with the system; translates the provided user input (from the microphone) and presents the data to the system for processing

Speech Announcer (Client): presents the system response to the user; translates the provided system input into speech and outputs this to the user through the speaker.

GPS Data Acquisition (Client): provides the sensory information to the other system components by retrieving the data from the GPS sensors; primary responsibility of this component is to gather the sensory information, process the data and present it in a meaningful format to the other system components.

Data Analyzer (Client): responsible for error checking data, controlling the system and requesting data from other system components.

Maps Data (Server): provides an interface to obtain web services data from the Google Maps API.

The physical model included the following characteristics

(1) The primary device (the PDA) is physically connected to the headphones and microphone.
(2) The PDA is connected to the internet via Wi-Fi.
(3) The PDA connects to the Internet to obtain map services and send SMS messages.
(4) A GPS receiver provides information to the PDA via Bluetooth.
(5) The system provides services to the presentation components of the system, for example, announcing real-time diagnostic data.

The diagram below illustrates the way in which class validation against the architecture was conducted. Each class that was identified was mapped back to the components defined in the system architecture.

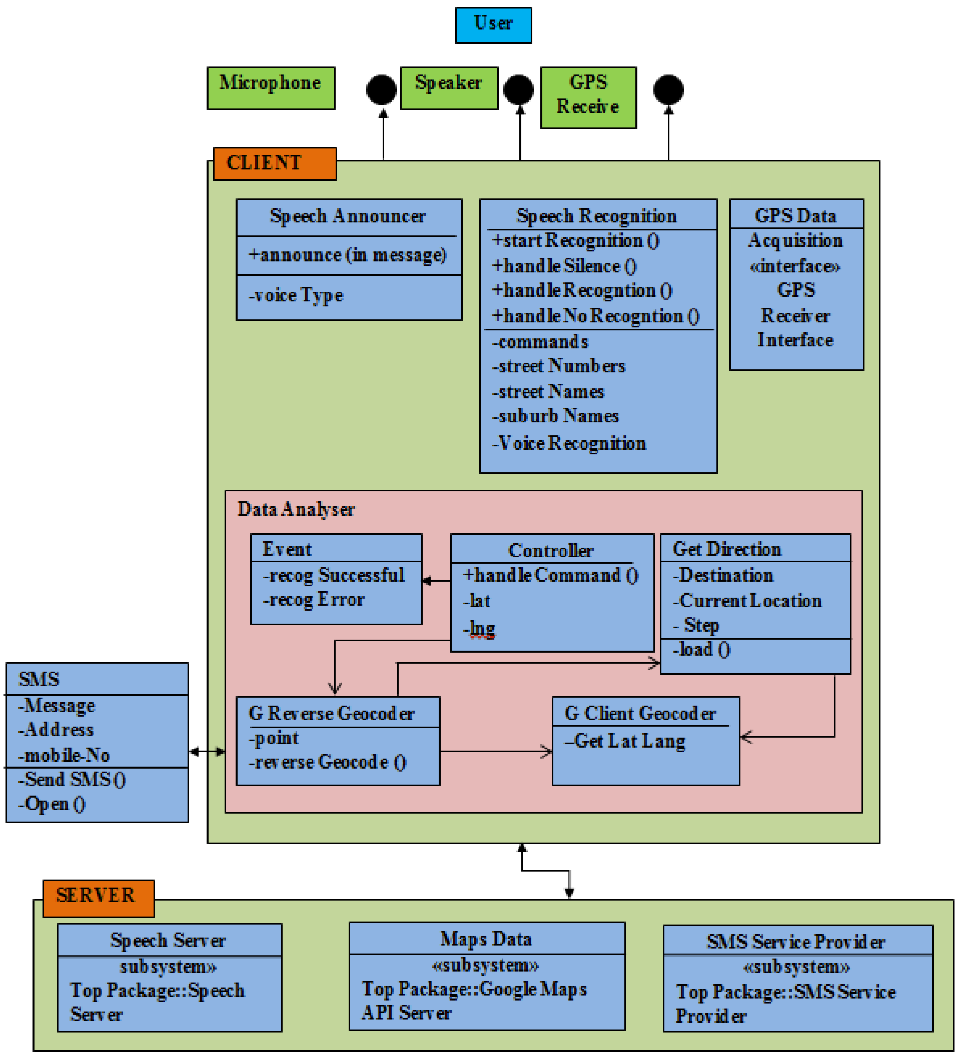

Figure2: How the design was mapped to the Client Server model

GSM: (Global System for Mobile communication) is a digital mobile telephony system. With the help of GSM module interfaced, we can send short text messages to the required authorities as per the application. GSM module is provided by SIM uses the mobile service provider and send SMS to the respective authorities as per programmed. This technology enables the system a wireless system with no specified range limits. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band. It is shown in Figure3.

Figure 3: GSM Component.

GPSGlobal Positioning System: The GPS smart receiver features the 16 channels .Ultra low power GPS architecture. This complete enabled GPS receiver provides high position, velocity and time accuracy performances as well as high sensitivity and tracking capabilities. The ultra-low power CMOS technology, the GPS receiver is ideal for many portable applications such as PDA, Tablet PC, smart phone etc.

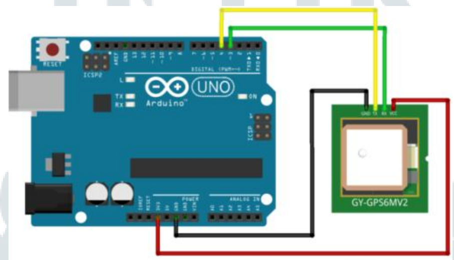

Figure 4: GPS Component.

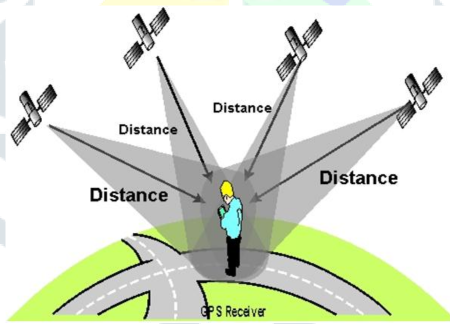

Figure 5: How does GPS works.

Accelerometer: An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer. By measuring the amount of static acceleration due to gravity, you can find out the angle the device is tilted at with respect to the earth. By sensing the amount of dynamic acceleration, you can analyze the way the device is moving. Accelerometers use the piezoelectric effect - they contain microscopic crystal structures that get stressed by accelerative forces, which cause a voltage to be generated. Another way to do it is by sensing changes in capacitance. If you have two microstructures next to each other, they have a certain capacitance between them. If an accelerative force moves one of the structures, then the capacitance will change. Add some circuitry to convert from capacitance to voltage, and you will get an accelerometer. The three axis accelerometer are basically used to identify the movements across the three axis i.e. x-axis, y-axis, z-axis. Accelerometer is an electronic device which is interfaced using I2C protocol and provides the reading after every 1msec. According to the requirement of the application, the microcontroller will take the reading from the accelerometer within a fixed interval of time and do the necessary operation according to the requirement of the application.

Figure 6: Accelerometer Component.

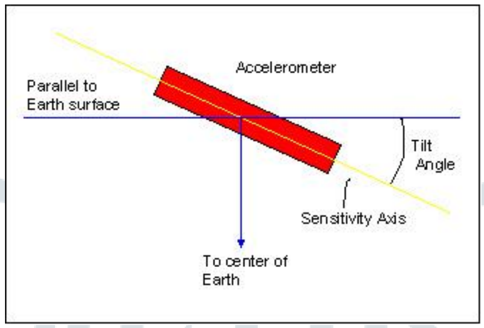

Figure 7: Schematic Working Of Accelerometer.

Radio-frequency identification: RFID reader is interfaced with the microcontroller. RFID reader works on Weygand protocol and transmits the wireless signal at 125 kHz. RFID readers have two data line i.e. DATA0 and DATA1. Both the lines are active low and are connected at the external interrupt pins (INT0, INT1) of the microcontroller. Logic 1 is transmitted on DATA1 line and logic 0 is transmitted on DATA0 line.

Interfaced RFID reader continuously transmits the electromagnetic field across it. The range is max of 10cm. when the RFID tag/card comes within this range; the RFID card gets powered up and provides their 26 bit ID data to the RFID reader.

IR (Infrared Sensor): Here we are connecting an IR based obstacle sensor. The 50 ohm resister is used for current limiting. The current through the LED is 5v / 50 ohm = 100 mump, which is high for an LED. But to increase the range of the obstacle sensor we are using a lower range resistor (50 ohm).On the receiver side we have connected the IR receiver in reverse bias. So as soon as the light falls in the IR receiver, the anode voltage increases and when the anode voltage is more than the cathode voltage then the LED is in forward bias mode and start conducting.

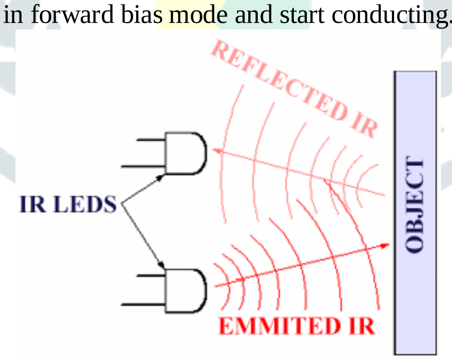

Figure 8: IR Sensor.

Ultrasonic sensors: They are basically used to measure the distances between the obstacle / object and the sensor. The ultrasonic sensor works on Doppler Effect. It consists of an ultrasonic transmitter and a receiver. The transmitter transmits the signal in one direction. This transmitted signal is then reflected back by the obstacle and received by the receiver. So the total time taken by the signal to get transmitted and to received back will be used to calculate the distance between the ultrasonic sensor and the obstacle.

Figure 9: Components of Ultrasonic Sensor.

VI.PRELIMINARY EVALUATION

The system operates under an assumption that only “expected” words need to be recognized. Other words are not being recognized as valid input. It is therefore important for the users to know the exact words they can say for the system to recognize their input. The main approach which is used to achieve this is to prompt the user for input. On start-up, the entire list of main menu commands are given to the user as the following prompt is played:

SYSTEM: Welcome to UC's main menu. To get your Current location say 'Current Location', to get directions say 'Get Directions,' to change Obstacle Detection say 'Obstacle Detection, to send an SMS, say 'Help'. To stop UC talking say ‘stop’ or ‘mute’ at any time.To exit say 'exit'. To hear these options again say ‘Main Menu’ or ‘Repeat’.

This is a necessarily long list, which takes a significant amount of time for the system to announce fully, as first time users would need to hear all of the necessary information. However, experienced users who already know the commands are able to interrupt the system at any time and skip to the desired function. An example of a user interrupting the system is given as follows:

SYSTEM: Welcome to UC's main me- USER: Current Location SYSTEM: You selected Current Location. You are currently located at 5 Aiken road, North Calcutta, India.

In this way, the system can flexibly cater to the needs of both first time users who require detailed instructions and experienced users who prefer fast performance. The following script provides an example of the system’s output for the Get Directions function.

USER: Get Directions SYSTEM: You selected Get Directions. Please say the destination street number or train station. USER: Sealdha Station SYSTEM: You selected Sealdha Station. Directions to Sealdha Station are: - Head east on Aiken Rd toward Salina Ave - Turn left at Saudan Road Hwy - Turn right at Cammac St - Turn right at Mongolian Road.

Table 1: Provides all of the standard user commands

Command	Description
Main Menu	Gives the following list of the main menu commands: To get your Current location say 'Current Location', to get directions say 'Get Directions,' to change Obstacle Detection say 'Obstacle Detection, to send an SMS, say 'Help'. To stop UC talking say ‘stop’ or ‘mute’ at any time. To exit say 'exit'. To hear these options again say ‘Main Menu’ or ‘Repeat’.
Current Location	Gives the current address: You are currently located at 5 Aiken road, North Calcutta, India.
Get Directions	Prompts the user for a destination address or station: Please say the destination street number or train station
Help	Prompts the user to say “Send” to send an SMS: To send an SMS for help with your current location say ‘Send’.
Repeat	Repeats the last system output again
Send	Sends an SMS with the current address: SMS has been Sent
Stop	Stops the current system output and listens to the user
Exit	Exits the program

The command words are standardized, but it is expected that the input from each user will vary according to their accent, pronunciation, and to a small extent, their word preference. For this reason, the system was designed to recognize common alternative commands which differ slightly choice of words. For example, the user may say “Location” instead of “Current location”. For the “Get Directions” feature, the system is capable of recognizing either an address or a point of interest such as the name of a train station. For the purposes of the proof of concept solution, street names in Sydney CBD and West Pennant Hills were loaded into the speech recognition system. Though the prototype list of commands is relatively short, it could be relatively easily extended to include a vast number of street names and station names without affecting the speed performance of the system. However, it is recognized that increasing the system’s vocabulary increases the likelihood of the system misinterpreting a command.

The current version of the prototype requires further work before it would be potentially suitable for a blind person. To give more meaningful directions for a blind user, we must know their orientation and tell them the directions relative to their orientation. It would also be much more useful if the system tells the user when they are walking in the wrong direction. The bearing necessary for this could be taken from a digital compass. In addition, it would useful to give approximate distances, for example, “turn right at Hannah St after 50 meters”. Ideally the system should be able to recognize the user’s voice and disregard background noise from the street. Implementing a mute function where the system stops listening for input would be an advantage. Alternatively, a “push to talk” configuration would help in limiting the impact of background noises. It would be desirable to providing a configuration file so that the user can configure User name, Mobile number (that the SMS gets sent to) and more street names and suburbs. This would allow the user to personalize the system so that their home suburb and places of interest will be recognized by the speech recognition system. It would mean that the system could send a more meaningful SMS for help to emergency services by including the person’s name. It would be possible to add a function to enable the user to request train timetable information. Assuming the user is traveling to a train station, the user might say “timetable, Northern Line”, to which the system might respond with something such as “The next trains are at 8:17am and 8:24 am”. The proof of concept system demonstrates that it is possible to obtain directions to points of interest (POIs) as it allows users to request directions to train stations. The system could be extended to include other POIs such as parks, hospitals, bus-stops, restaurants, and shops. This extension would only be limited by the Google Maps API being capable of servicing these requests. Ideally, as the visually impaired person moves through the environment, he/she would hear the names of buildings, street intersections, etc. spoken as though coming from the appropriate locations in auditory space as if they were emanating from loudspeakers at those locations. Besides leading the visually impaired person along a desired route, the system would hopefully allow the person to develop a much better representation of the environment than has been the case so far.

VII.LIMITATION

The current system has few limitations. Environmental conditions play a major role. The camera may not provide much assistance during the night time and also fails to detect obstacles approaching the user from his/her back. During rainy season it may be difficult to operate the system as it may disrupt the connections. In the case of presence of any bugs the user is helpless in regards to debugging or reprogramming the code.

VIII.CONCLUSION

Currently available electronic navigation aids have not received any great level of support among the blind community. The vast majority of visually impaired people prefer to not use electronic aids, and use only canes or guide dogs. It is proposed that the underlying reasons for this include the relatively high costs and relatively poor levels of user satisfaction associated with existing electronic systems. The work undertaken in this project investigated the suitability of a user-centric client server approach for the development of a new electronic way finding system intended primarily for people who have impaired vision. Speech recognition technology was identified as being a suitable basis for the interface of the system. The project successfully delivered a functional prototype that uses intuitive hands-free voice recognition technology. The client server model enabled the system to make use of existing tools including the MS IE Speech Add-in and the Google Maps API. In addition, the client server approach enables much of the processing to be undertaken in remote locations, rather than on the user’s hardware. The prototype solution is intended to be suitable for further extensions including an electronic compass, announcing distances (in meters), using push-to-talk to reduce the effect of background noise, and adding additional configuration capabilities. In addition, the system may be augmented by the provision of additional services such as the ability to access train and bus timetable information. Further, a digital compass may be supplemented by other sensors for the purpose of obstacle avoidance. The client server approach draws on well understood principles, and was found to be suitable for the development of this type of application.

REFFERENCES

[1] http://www.who.int/mediacentre/factsheets/fs282/en/

[2] Zelek, J., 2002. “The E. (Ben) & Mary Hochhausen Fund for Research in Adaptive Technology for Blind and Visually Impaired Persons.” Available fromURL:http://www.eos.uoguelph.ca/webfiles/zelek/cnib2.pdf.

[3] International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-3, Issue-1, January 2015 for location finding for blind people using voice navigation stick by Pranjali R Phirke, JayshreePande, Prof. Archana Singh.

[4] “Electronic Interfaces Aiding the Visually Impaired in Environmental Access, Mobility and Navigation” 978-1-4244-7562-9/107©2010 IEEE.POLAND, pp. 13-15, 2010

[5] Mahdi Safaa A., MuhsinAsaad H. and Al-Mosawi Ali I. "Using Ultrasonic Sensor for Blind and Deaf persons Combines Voice." International Science Congress Association, 50-52, 2012.

[6] Voice Operated Guidance Systems for Vision Impaired People: Investigating a User-Centered Open Source Model by Bruce Moulton, GauriPradhan, ZenonChaczko, doi: 10.4156/jdcta.vol3.issue4.5

[7] HammS.(2008).IBM’sSpeechRecognition, Business Week,http://www.businessweek.com/innovate/content/aug2008/id20080818_745252.htm

[8] Borenstein, J. (1997) A Computerised Travel Aide for the Active Guidance of Blind Pedestrians, Proceedings of the IEEE International Conference on Robotics and Automation, Albuquerque, NM, Apr. 21-27, 1997, pp. 1283-1288.

[9] MyNetFone (2005). MyText SMS API, https://www.mynetfone.com.au/residential-voip-solutions/features/mytext-sms/mytext-sms-api.

[10] Moulton, B. and Y. Forrest (2005) Accidents will happen: safety-critical knowledge and automated control systems. New Technology, Work and Employment, Vol. 20, No. 2, 102-114.

[11] HuiZhang; Goldman, S.A "Image Segmentation using Salient Points-Based Object Templates" Image Processing, 2006 IEEE International Conference on Image processing: 2006, Page(s): 765 – 768.