RESEARCHERID
THOMSON REUTERS

[Thumma* 4(6): June, 2017] ISSN 2349-4506
Impact Factor: 2.785

Global Journal of Engineering Science and Research Management

LOCATION BASED NAVIGATION AND OBSTACLE DETECTION SYSTEM WITH VOICE ALERTS FOR BLIND

Chandni Asvitha Thumma*, Shravya Amarnath, Hanna Philipose, Gayathri. P
* School of Computing Science and Engineering, VIT University, Vellore, Tamil Nadu, India

DOI: 10.5281/zenodo.805435

KEYWORDS: GPS, GSM, Arduino Uno, Ultrasonic Sensor, Voice alerts.

ABSTRACT
In the present scenario, a blind person is compelled to rely on another person and cannot travel independently to any place without the help of others. This project aims to develop a smart stick for the visually impaired people. The smart stick will include a GPS/GSM system and obstacle detection mechanism. The GPS system is used by the user to know the current location and also to notify his friend or relative about the current location. This could result in a better movement of the user. A voice module will be attached so that the stick can alert the user about the obstacles and the current location name whenever necessary. GSM is used to send the message about the current location to his friend or relative and the current location announcement which involves text to speech conversion is given to the user by the system.

INTRODUCTION
Visual impairment can limit people's ability to perform everyday tasks and can affect their quality of life and ability to interact with the surrounding world. Blindness, the most severe form of visual impairment, can reduce people's ability to perform daily tasks, and move about unaided. Good quality rehabilitation allows people with different degrees of visual impairment to fully profit from life, achieve their goals and be active and productive in today's society. Ample efforts have been made to aid the blind by innovating and improving technologies. According to [23] "The emerging ethics of human centric GPS tracking and monitoring", the main factors focused while tracking a person are privacy, accuracy and accessibility.

By the introduction of a basic sensor, the provisions to the aid of blind people have remarkably increased. Many universities and companies like IBM have given a part of their focus to the development of aids for the blind people. Some of the popular ones are smart canes and obstacle sensors. Recent development includes self-driving cars and smart glasses. In the last 30 years, various other strides that have been developed are the text or speech softwares and smartphone apps. Moreover the systems that are being developed on robotics and artificial intelligence will be very advantageous to them as well.

One of the major factors in developing these technical aids is the compatibility with the user. He should not have trouble getting acquainted with the product. The features of the product should not be too difficult to use. Even the notification systems used to alert the blind should be comfortable and reliable. Another major factor is the cost of such products. Since they are already paying for treatments or other nursing cares, the price of the product should be in the range that is reasonable. Other feature of these products should be the durability. The users might not be able to charge the system. So, appropriate measure should be taken for it.

To aid visually impaired and to provide a compact and complete solution, a smart stick can be developed which will include a GPS system, obstacle detection mechanism and an audio module, so that the stick can instruct the directions to the user. The obstacle detection mechanism is combined with navigation and location detection using GPS-GSM and an audio module with Bluetooth transceiver to provide a better solution than the already existing solutions.

The technologies we plan to use are sonar technology, GPS navigation, GSM network, voice recognition and notification. Sonar technology is used for obstacle detection. The principle of the system works in the way that the detector sends and receives a signal. Upon the reception of the signal, the distance is calculated using the time it took for the signal to reflect back. It is a simple procedure which works with the properties of electromagnetic waves. This is mainly used to find distances in various fields.

Obstacle detection is done by ultrasonic sensors attached to the stick. The sensors are selected to satisfy their criteria of sensor angle, distance and other parameters. When the sensors come across some obstacle, it sets off a voice announcement from the set of announcements already recorded, according to their semantics and alerts the person about the obstacle in the path. In order to reduce the noise and sound dissipation, an earpiece is attached to give the audio announcements. The GPS system is used to detect the current location and helps the user to reach the destination by announcing the current location name whenever required by the user and also in case of an emergency, the location of the blind person can be sent to a relative or friend via SMS.

LITERATURE REVIEW

Existing paper works and solutions related to GPS-GSM, and Obstacle detection reveal that, so far, all these technologies have been implemented individually but not integrated for the cause of the blind.

Obstacle Detection:

In sonar technology, sound propagations is used to navigate , communicate with or detect objects on or under the surface of the water, such as other vessels. This technology can be mainly divided into two types- passive and active. In passive sonar, when the vessels make sound, they listen to it. Active sonar is emitting pulses of sounds and listening for echoes. This is the mechanism we will be working with. This is primarily used for acoustic location tracking.

Ultrasonic technology is always in research very deeply because of the vast different ideas it can harbor. Moreover, due to its technological breakthroughs in various applications, the sensor is incorporated more and more widely. Some of the applications of ultrasonic sensor are parking sensors, robot avoid obstacle, level detections and its applications in the toxic, harmful and corrosive environments. Ultrasonic sensors are very well used for sensing applications in the areas of engineering, physics and medicine.

Smart walking stick for visually impaired [1] incorporates artificial vision and object detection integrated with GPS to enable the user to know about the environment for efficient navigation. Although it is an advanced technology, lack of voice recognition to input the destination is a disadvantage to this system.

Obstacle Detection in Unfamiliar Indoor Environments [2] comprises of a Kinect unit, a Tablet PC, a microcontrol-ler, IMU sensors, and vibration actuators. These vibrators minimize the reliance on audio instructions for avoiding obstacles. It can also guide the blind to reach a de-sired destination (office/room/elevator) within an unfamiliar building with the help of RGB camera of Kinect unit,2-D printed codes, a compass sensor for orienting the user towards the next direction of movement, and synthesized audio instructions. The system is heavily equipped and needs complex and heavy computations and processing which lead to rise in costs and energy consumption.

Enhancement of smart cane [3] talks about a method which uses a smart cane to detect and notify obstacles. The notification is done to the user with the help of his smart phone. The sensors in the cane detect the distance between both the user and the obstacle. It also uses a gsm module in the system to track his location. It also uses a trivial accelerometer to detect uneven topologies. This helps a great lot to avoid accidents. Only limitation is that every user should be equipped with a smartphone because the data from the sensors are collected by the phone. These data is then transferred to the user by the help of an earphone.

Design and development of secure navigation system for visually impaired people [4] is an infrared based detecting system and it announces obstacles in the user's path. This system also gives the necessary guidelines for the user to avoid the obstacles. This notification is done by vitro-tactile or sound feedback. In this system, a light weight sensor is attached to a head cap so that the user is informed about the obstacles near to the head area. This provides an advantage over the simple walking stick.

Obstacle detection gadget for visually impaired people [5] obstacle detection system proposed is based on infrared and the output is provided by buzzers and vibrators. This system is used for indoor obstacle detection.

Enhanced independence free path detector to blind people using gsm has been proposed in [6]. Infrared technology is used for shoulder width field view from knee to head level. This significantly increases the field of view, but the infrared rays are easily shielded which reduces the efficiency and effectiveness of the system.

Blind Aid using Radio Frequency Identification (RFID) and Ultrasonic sensors [7] uses RFID technology and ultrasonic sensors to help in improved navigation, but RFID has its own constraints like interference and complexity due to RFID tagging of every object in the vicinity.

GPS Navigation:

Global positioning system is defined to be a network of satellites that are orbiting around the earth. These satellites send accurate details of their position in space back to earth. These signals are received by the GPS receivers. Some of the GPS receivers include navigation devices. This gps technology was first introduced by the US for its military purposes in the global intelligence efforts for the Cold War. But after 1980s, GPs has been made available to everyone who owned a GPS receiver. Since then it has been mainly used for location tracking.

Application of GPS is categorized as location, navigation, timing, mapping, and tracking. Each category contains its single or combined uses in the fields of military, recreation, transportation and science. The applications in tracking mainly revolves around monitoring individuals and objects such as packages. This has been used in combination with wireless communications to keep track of criminals and other important people. In case of the criminals, the suspect is made to wear a gps receiver and the transmitter with him. His locations are monitored and if he is found to being places where she was not supposed to be, then the authorities will take necessary actions. It is used to track animals also.

Navigation is understood as the process of reaching one position to another. This was the original objective for developing GPS. This system allows us to travel on water, air or land. It allows planes to land in the middle of mountains and helps medical evacuation helicopters save precious time by taking the best route. Voice alert for blind [8] with the help of GPS system, the current location of the blind is received and the coordinates are compared with the prerecorded destination coordinates. A voice alert is given to the user on a match of the coordinates. Animal tracking and health monitoring has been proposed in [9]. Location tracking of the animal is made possible with the help of GPS-GSM system and other body sensors are used to sense the heart rate, temperature and many more to monitor the health of the animal.

GPS/GSM person tracking [10] is used to locate the coordinates of criminals but a problem associated with this system is that the criminal should be in the range of either the GSM tower signals or in a GPS signal receiving area. In real time passenger information system [11] estimated arrival time of buses is announced at the bus stops based on the tracking of the bus using GPS. Large number of requests at a time might delay the system response. In passenger tracking [12] the location of a passenger on a train/bus is detected based on the ticket number. The ticket numbers are stored in a database linked to the updates of the vehicle location using GPS.

Ethics of human tracking [13] uses GPS and analyzes the uses and the applications of human tracking. It divided the applications on the basis of control, convenience and care. The main features that were considered are privacy, accuracy, property and accessibility. In [14], Bluetooth based notification system for the blind people have been proposed. JSON technology is used to create an application that will help the blind person to determine which bus is coming at the bus station. JSON is considered apt for this data exchange because it is user friendly and easy for computers to parse and use. Bluetooth devices are switched on and they collect data and send it to the database. From the database, required data is achieved in the text format. Notification is received by the user using the text to voice converter.

In [15], Analysis of Bluetooth device discovery protocol has been proposed. Piconet is the basic networking unit for the protocol. It adopts the device which initiates the discovery as the master and rest of the devices is slaves. The various states of the discovery protocol are standby, connection, inquiry scan, inquiry response etc. One disadvantage to be mentioned is discovery time is highly variable. Table 1 shows the comparison of different components used in the literature review.

ISSN 2349-4506
Impact Factor: 2.785
Global Journal of Engineering Science and Research Management

Table 1: Comparison on study of different components

Reference No.	Hardware							Cost Effective	
	GPS	GSM		Microcontroller/Microprocessor		Voice Module	Sensor	Yes	No
		GPRS	SMS	ARM	PIC				
1	√				√	√		√	
2	√		√	√			√		
3	√	√						√	
4	√		√	√				√	
5	√	√		√				√	
6	√	√				√			

The papers referenced above deal with individual aspects of easy navigation for a blind person. We intend to bridge the gap by integrating all the essential components in a single system to provide a one stop solution to all the facilities a blind person may require for easy navigation and usability. The system to be designed shall incorporate obstacle detection methods along with navigation using Audio controls. Since vibrations are generally not good for the human body and it may also lead to a sense of irritation, our system shall be audio centric .To enable the user to sense the size of the obstacle, various voice announcements corresponding to type of input will be given as output. To overcome the problems associated with wearable, the system shall be planned to be placed on the white stick, which a blind person is naturally acquainted to.

Table 2 summarizes the technologies used in the literature review.

Table 2 Technologies used

Equipment/Technology	Description	Advantages/Disadvantages
Infrared	Transmission of electromagnetic waves	Easily shielded, not accurate
RFID	Transmission of electromagnetic waves which reads from RFID tags	Requires RFID tags, Not efficient specially in outdoor environment
Ultrasonic	Transmission and reception of ultrasonic waves	Covers reasonable range,Cost effective,provides 60 degree filed of view
Laser	Transmission and reception of light waves	Not efficient in broad daylight,easily shielded,very high price

PROPOSED SYSTEM

The system consists of the major modules such as obstacle detection, navigation aid using GPS, location detection using GSM and Voice announcements. Figure 1 depicts the overall system design.

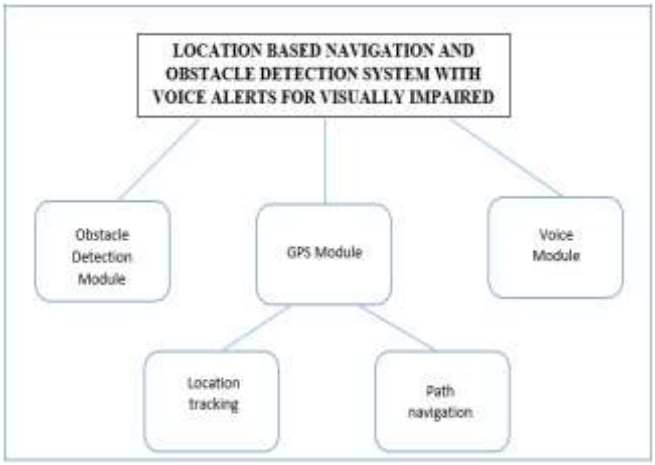

Figure.1 System design

Obstacle Detection:
This component shall help the user avoid obstacles in the range of 0-4 feet by beeping differently depending on the position and proximity of the obstacle detected. The ultrasonic sensors are used which transmit ultrasonic waves and receives the response that are reflected by the obstacles around continuously. The response is analysed by the microcontroller to measure the distance between the user and the obstacle. This triggers the corresponding output, which is a voice announcement mentioning the direction of the obstacle to alert the user over the speaker.

Navigation Aid using GPS:
This component shall help the user navigate to the chosen destination by alerting the person about the current location when the location announcement button is pressed. GPS is used to extract the current coordinates of the user which shall be input into the microcontroller to compare with the data stored in the SD card. Once a match of the coordinates is found the location name corresponding to the coordinates is announced. These announcements are made using text to speech conversion in the Arduino.

Location Detection using GSM:
In case of an emergency, when the user wishes to alert his friend or relative, the user on pressing the alert button, the current location coordinates received from the GPS system will be sent via SMS. The SMS sent will include the Google maps URL link to which the coordinates of the blind user are appended. When the friend or relative taps on the link, the person is automatically redirected to Google maps showing the coordinates of the blind user.

Voice Announcements:
Text to speech conversion is performed with the Formant synthesis method. This method gives a robotic voice and not human voice as output. This is due to the alterations of the frequency or pitch which creates a waveform. Thus, based on the waveform produced, the voice output is produced over the speaker. The announcement is made using this method, since it is not feasible to record all the location names which requires a huge database.

Figure 2 shows the detailed setup of the proposed system.

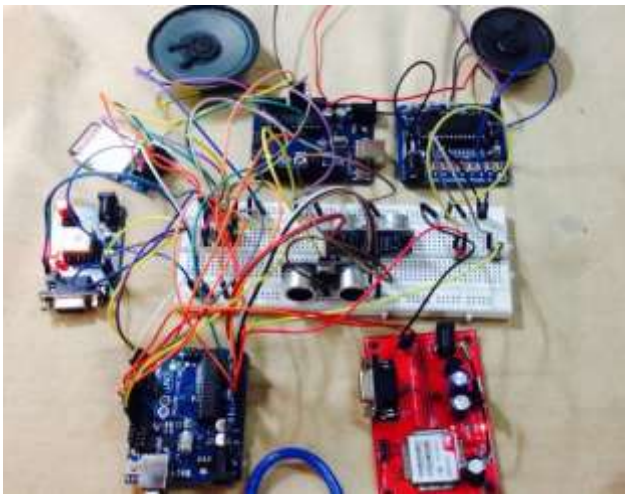

Figure.2 System set-up

All these components can also be placed in a very compact way to be attached on to a walking stick.

SYSTEM REQUIREMENTS

Hardware Requirement:

Arduino Uno: Uno is a microcontroller board with ATmega328P and it has clock speed of 16MHz.It has 14 digital I/O pins out of which 6 can be used as PWM digital I/O pins and another 6 analog input pins. The microcontroller ATmega328P has a Flash memory of 32KB,SRAM of 2KB and EEPROM of 1KB.It operates at 5V and it can handle an input voltage of upto 12V.

Ultrasonic sensor (HC-SR04): HC-SR04 is an ultrasonic sensor using sonar to compute the distance of any obstacle in its range. It has a distance range of 2cm to 400cm with an effectual angle of 15^0. It operates at 5V input voltage and its ultrasonic frequency is 40kHz. It has 4 pins(VCC pin, Echo pin, Trig pin and GND pin.) and a transmitter and a receiver to emit and receive the ultrasonic waves.

Voice module (APR33A3): APR33A3 is a high quality voice record-ing/playback IC with 680 sec of recording length. It operates within 3V to 6.5V volt-age range. It has 28 pins out of which 8 act as inputs for messages and 2 act as outputs for speakers.

GPS: GPS L80 is low power consuming device with horizontal accuracy of <2.5m, velocity accuracy of <0.1m/s, timing accuracy of 10ns and reacquisition time of <1s. It operates at a voltage range of 3V to 4.3V

GSM/GPRS: Sim900A module is quad-band (850/900/1800/1900MHz) with low power consumption of 1.0mA(sleep mode).It is compatible with FTP/HTTP and it also has TCP/UDP protocol embedded. It also supports SMS and MMS. It operates within the voltage range of 4.2V to 13V and current consumption of 40mA to 590mA.

SD card: The internal memory is of 8GB and it is of the flash card type. It is based on micro secure digital high capacity. Memory adapter is included.

Speaker: 8 ohm speaker with no polarity.

SOFTWARE REQUIREMENT

Arduino 1.6 is used for Arduino boards. It is an open-source software compatible with Windows, Mac OS X and Linux. Its environment is written in java and is based on Processing and other open-source software. The programming is done in C/C++.

RESULTS AND DISCUSSION

In obstacle detection module, we have used the voice module to give outputs instead of the buzzer. From the existing aids we have seen in the papers, we have concluded that continuous buzzing or beeping may cause irritation and stress to the user. Hence we tried to improve on that with voice announcements. Voice announcements are used to differentiate the position of the obstacle as two different sensors are used to detect. Average speed of normal person is 1.3 m/s or 4 feet/ s. According to some papers, the average speed of blind people without a helping aid is 0.3m/s and that of blind person with the aid is 0.5m/s. We introduced our system to some of the novice users to analyse the user adaptability. The user was able to attain a speed of 0.6m/s and was able to get well acquainted with the system in 2 or 3 attempts. The accuracy of the system is better compared to the existing aids. The vertical coverage of the detection system is up to 2 feet from the ground level, as it includes top and bottom sensors.

The GPS module used in the system has a Dilution of Precision (DOP) of <2 which is an ideal precision. On comparison with the already existing systems that have a DOP of around 5, it is clear that this is a better system. The GPS module of this system has a reacquisition time of <1s which when compared to the other existing systems that have a reacquisition time of <2s is better.

The GSM module sends the message immediately to the friend or relative without any delay and the corresponding receiver was able to successfully open the Google maps of that particular location. Figure 3 and Figure 4 are snapshots of the message received and the Google maps webpage on the receiver end.

Figure.3 Received message

Figure.4 Corresponding google maps

The current location announcements were announced successfully by comparing the data in the SD card and using text to speech conversion. Since, the voice is robotic in nature, the user required some time to get accustomed to it.

CONCLUSION

The purpose of the proposed work is to come up with a product that acts as an aid to the visually impaired people. By analyzing the existing aids and coming up with our own idea to make a better aid, mainly three modules- obstacle detection, location tracking and SMS alert were concentrated. All these modules work perfectly and the system was made to function more user friendly by including a voice module. Voice module and speaker is used as an output interface, while the buttons act as the input interface. The future improvements can be the following:

1. Bluetooth technology can be incorporated instead of the normal earphones or speaker in order to make the announcements clearer without any external noises.
2. Instead of using the conventional DC batteries, solar charged batteries can be used to make the product Ecofriendly. This also gives an added advantage to the user, which is, the user need not charge the system consciously.

REFERENCES

1. Dambhare, Shruti, and A. Sakhare. "Smart stick for Blind: Obstacle Detection, Artificial vision and Real-time assistance via GPS." In 2nd National Conference on Information and Communication Technology (NCICT).2011; 2:31-33.
2. Al-Shehabi, Monther M., Mustahsan Mir, Abdullah M. Ali, and Ahmed M. Ali. "An Obstacle Detection and Guidance System for Mobility of Visually Impaired in Unfamiliar Indoor Environments." International Journal of Computer and Electrical Engineering. 2014;6(4): 337-341.
3. Jeslin, J. Gnana, A. Vaishnavi, and J. Nivedha. "Enhancement of Smart Cane To Detect And Notify Obstacles.". International Journal of Engineering Research & Technology (IJERT) 2015;4(2):1-3.
4. Bhardwaj, Prashant, and Jaspal Singh. "Design and Development of Secure Navigation System for Visually Impaired People." International Journal of Computer Science & Information Technology.2013;5(4): 159-165.
5. Sudhakar, K., Priyank Saxena, and Sudhanshu Soni. "Obstacle Detection Gadget for Visually Impaired Peoples." International Journal of Emerging Technology and Advanced Engineering.2012;2(12):1-5.
6. Bharathi, S., A. Ramesh, and S. Vivek. "Effective navigation for visually impaired by wearable obstacle avoidance system." In Computing, Electronics and Electrical Technologies (ICCEET), 2012 International Conference on, IEEE, 2012; 956-958.
7. Roopsai, V., S. Selvarathinam, and K. G. Varun Krishna. "Blind Aid using Radio Frequency Identification (RFID) and Ultrasonic sensors." International Journal of Computer Science and Electronics Engineering.2013;1(1)-96-100.
8. Gulati, Rishabh. "GPS Based Voice Alert System for the Blind." International journal of scientific and engineering research.2011;2(1):1-5.
9. Khatal Sachin Sahebrao," GPS/GSM based animal tracking and health monitoring system"International journal of Engineering,Education and Technology.2015;3(2):1-4
10. Khan, Abid, and Ravi Mishra. "GPS–GSM based tracking system."International Journal of Engineering Trends and Technology.2012;3(2):161-164.
11. Ganesh, K., M. Thrivikraman, Joy Kuri, Haresh Dagale, G. Sudhakar, and Sugata Sanyal. "Implementation of a real time passenger information system." arXiv preprint arXiv:1206.0447.2012;1-14.
12. Kumar, Vijay. "GPS and GSM based Passenger Tracking System."International Journal of Computer Applications.2014;100(2):30-34.
13. Kargl, F., Ribhegge, S., Schlott, S., & Weber, M. (2003, January). Bluetooth-based ad-hoc networks for voice transmission. In *System Sciences, 2003. Proceedings of the 36th Annual Hawaii International Conference on* (pp. 9-pp). IEEE,2003:9-14.
14. Aher, R. R., Gupta, N. A., Khairnar, A. G., Thanki, K. B., & Gaidhani, A. R. (2014, January). Bluetooth Based Notification System for Blind People Using JSON Technology. In *International Conference of Advance Research and Innovation.*2014:1-4.

15. Chakraborty, G., Naik, K., Chakraborty, D., Shiratori, N., & Wei, D. (2010). Analysis of the Bluetooth device discovery protocol. *Wireless Networks*, *16*(2), 421-436.