OUTDOOR NAVIGATION SYSTEM FOR VISUALLY IMPAIRED

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***Abstract*—**
Mobility of visually impaired people is restricted by their incapability to recognize their surroundings. According to the World Heal th Organization (WHO) in 2019, out of 7.8 billion global population there were over 2.2 billion visually impaired people and 1 billion were totally blind out of which 312 million are children (under 19 years of age). This means that someone in our world goes blind in every five seconds and a child in every minute. Over 90 percent blind children obtain no schooling. Recent survey source India is no w becoming the world's large number of blind people. The population of India has reached 120 Cr. of those 8.90 Cr. people are visu ally impaired. 90%of those cannot travel independently. In this paper, we present a survey of the navigation system of visually impai red people highlighting various technologies with their practical usefulness, design and working challenges and requirements of blin d people. The aim of this review paper is to provide a better understanding to identify important research directions in this increasi ngly important social area for future research.

***Keywords*—**
: Outdoor Navigation system, visually impaired, Arduino uno, obstacle detection, mobility, localization, situation awareness, outdoor navi gation, GPS, water sensor, infrared sensor, ultrasonic sensor.

I. INTRODUCTION

Fig.1- Navigation Stick[1]

Visually challenged persons face constraints in independent mobility and navigation. Mobility means the possibility of liberally moving, without support of any supplementary person, at home and unfamiliar scenarios. People with visual impairment tackle enormous limitations in terms of mobility. A system which guides or assists people with vision loss, ranging from partially sight to totally blind, by means of sound commands is referred as Navigation assistance for visually impaired (NAVI). Many researches are being conducted to build navigation system for blind people. Most of these technologies have limitations as its challenge involves accuracy, usability, interoperability, coverage which is not easy to overcome with current technology for outdoor navigation.[25]

To navigate from one place to another these people rely on some supportive devices like guide dogs, canes and many more. There are many problems related to navigation for these people. Thus, there is a need to develop a system for visually impaired people that would help them to navigate from one site to another with effectiveness and accuracy. The system would assure with the help of a self-governing life to these people. By this system people who are not able to see would become more confident like sighted people. The assistance which is implemented is a navigation cane. Various sensors are employed in the system including an ultrasonic sensor for detecting soil obstacles. The system focuses on liquid and solid both the objects. The sensor detects the solid object within 90 cm range. The sensor works as a wave transmitter and receiver. The transmitted wave would fall on the obstacle and then be received back by the sensor. For outdoor localization GPS (Global Positioning System) is used. After getting an indication about the obstacle the person can avoid it easily. Therefore, the system provides an ease to visually impaired people to identify what is present in front of them. If we come to a liquid obstacle identification, a water sensor has been used in the system. The sensor senses the obstacle that is in liquid form and sends signal to a microcontroller associated with the system.[26]

II. LITERATURE REVIEW

The basic requirement for developing any system is to understand the existing systems in that field. Over the time, there have been multiple proposals and innovations regarding developing a system for visually impaired people. Many of them have been successfully proved to be helpful and cover a wide range of criteria. To live an independent and struggle free lifestyle, visually impaired people are needed to learn certain skills and techniques such as Braille. The very basic one is White Cane, which is the cheapest and affordable basic implementation. But this Cane does not cover all the aspects and specifications required to make a complete system for outdoor navigation such as obstacle detection. As an improvisation to this innovation, some of the advance techniques include:-

1. NAVI-
   Navigation assistance for visually impaired refers to systems that are capable to assist or guide people with vision loss, ranging from partially sighted to totally blind, by means of sound commands. Many researchers are working to assist visually impaired people in different ways like voice based assistance, ultrasonic based assistance, camera based assistance and in some advance way researchers are trying to give transplantation of real eyes with robotic eyes which are capable enough to plot the real image over patient retina using some biomedical technologies. [1]
2. Text-Telephone (TTY), which consist of Braille signs.[2]
3. Doubletalk LT, speech synthesizing device, that converts text into electronic speech.[3]
4. Multidimensional Walking Aid Using Ultrasonic Sensors Network with Voice Guidance-
   The design consists of three stages which are power, control and output stages. [4]
5. Voice Based Guidance and Location Indication System for the Blind Using GSM, GPS and Optical Device Indicator- This system is intended to provide overall measures –
   object detection and real time assistance via Global Positioning System(GPS).The system consist of ultrasonic sensor, GPS Module, GSM Module and vibratory circuit(speakers or headphones). This project aims at the development of an Electronic Travelling Aid (ETA) kit to help the blind people to find obstacle free paths. [5]
6. Electronic Guide Cane with Ultrasonic eyes for Visually Impaired-
   It enables users to effectively scan the area in front and detect obstacles on the ground like holes, steps, walls, uneven surfaces, downstairs etc .but it can only be used to detect obstacles up to knee-level. Its detection range is limited up to 1-2 feet only. [6]
7. Outdoor Navigation with Voice Recognition Security Application for Visually Impaired-
   Since visually impaired people are more sensitive in hearing and possesses strong perception than ordinary people. So this system gives alert through vibration and voice feedback. [7]
8. Navigation system for blind pedestrians using RFID tags-
   A mobile receiver provides navigation guidelines based on the code saved in each tag. This system overcomes the GPS navigation limits in the indoor environment and does not need any power supply for location markers. [8].

9. Guide dog service-
   These dogs are trained to lead blind and visually impaired people around obstacles. Although dogs can be trained to navigate various obstacles, they are red–
   green color blind and incapable of interpreting street signs. The human does the directing, based on skills acquired through previous mobility training. The handler might be likened to an aircraft's navigator, who m ust know how to get from one place to another, and the dog is the pilot, who gets them there safely. [9].
10. Blind audio Guidance system-
    It is an embedded system that uses ultrasonic sensor for distance measurement, IR sensor for object detect ion and AVR sound system for audio instructions. The main functions of this system are environment reco gnition and path detection. However, only issue of this system is the difficulty to know one's location glob ally [10]
11. ROSHINI –
    In this system, the user's position is determined in the building, navigated with the help of audio messages by pressing keys on the mobile unit. Sonar technology is used to identify the position of user by mounting ultrasonic modules on the ceiling at regular intervals. [11]
12. DRISHTI-
    This can switch the system from an indoor to an outdoor environment with a simple voice command. To p rovide complete navigation system, authors extend indoor version of Drishti to the outdoor versions for bli nd pedestrians by adding only two ultrasonic transceivers that are smaller than a credit card and are tagged to the user's shoulder .[12]
13. NavBelt-
    Based on navigation and obstacle prevention technologies that are originally designed for mobile robots. T his system consists of eight ultrasonic sensors worn on a user's waist like a belt, a portable computer on hi s/her backpack, and a stereophonic headphone. [13]
14. RGB-D camera with tactile devices- For real-time navigation with obstacle avoidance. The RGB-
    D camera generates depth data registered with RGB images, and traverse ability maps are provided to indi cate free and occupied (obstacle) spaces. Instructions such as "Go straight" and "Turn right" are given to a consumer via four micro vibration motors on a jacket. [14]
15. Wearable jacket-type-
    Sonar sensors and vibrators are attached on a jacket, and are used to let a consumer know the direction fro m which an obstacle is coming. [15]
16. Smart shoes for blind –
    It consist of multiple depth, obstacle detection and RGB sensor. A control board to detect multiple levels of obstacle and the ground object. Sound recording and playing module for voice assistance. [16]

Some of the major drawbacks of these systems are that they are not dynamically viable. Every other proposal has some limitations and does not cover all the aspects.

III. RELEVANT THEORY & METHODOLOGY

Our proposed system provides a thoughtful approach in providing a comfortable solution to the people. It covers ce rtain limitations of other Innovations such as Detection of obstacle above waist, Detection of type of obstacle, Tra cking of the visually impaired person across the area, Enhanced Alert system and many more factors. The main pu rpose of this project is to Design and develop a Blind Stick having multiple depths and obstacle detection. It consis ts of two parts:- Tracker module and Sensor module.

The Sensor part will sense the upcoming obstacles in the path of the person using Ultrasonic and IR Sensor , which will further determine the type of obstacle such as Water or Physical obstacles such as Pits and drains. This will al ert the person of any danger beforehand using the Vibration sensor attached to the Stick. This vibration sensor is h elpful in the case if the person is Deaf and may not be able to listen to the Voice assistant alerting him of danger.

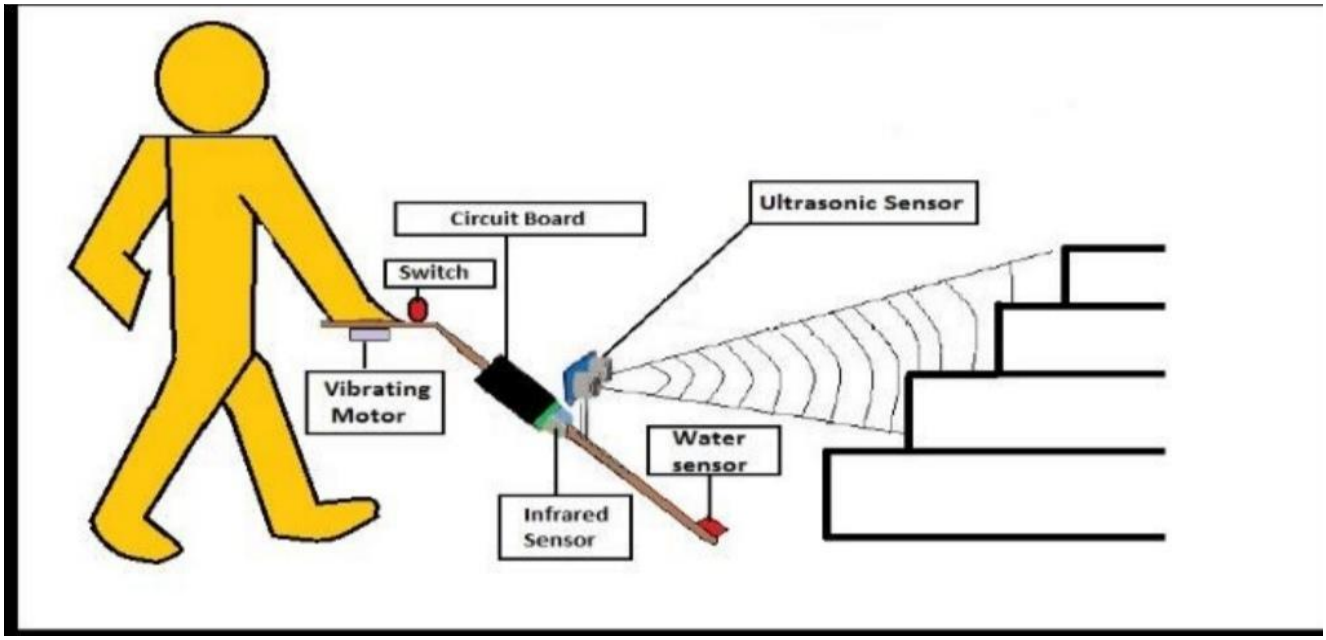

Fig.2-Working of Navigation Stick[11]

Similarly, the Tracker part will alert any relative of the user using the GPS module which will provide the exact lo cation of the user if he or she is in any danger. The Alert system will consist of GPS and GSM modules which will act as a communication device specially for Outdoor Navigation.

A. Abbreviations and Acronyms

a. NAVI – Navigation Assistance for Visually Impaired

GPS- Global Positioning System
TTY- Text- Telephone
GSM- Global System for Mobile
ETA- Electronic Travelling Aid

B. Equations

The Ultrasonic sensor used for detection of obstacles works on the principle of Trigger and Echo, where the ra ys are triggered from one pin of the sensor and after being reflected from the object , is received by the Echo p in. In doing so, it measures the distance of the object using the formula,

$$D= (t*c)/ 2$$

d: object distance (m)
t: time delay between wave emission and echo reception (s)
c: Ultrasonic sound velocity (m/s)
Hence, it is able to detect the distance of the object and alert the person.

Flowchart:-
This mechanism of detection and tracking is explained more vividly in the following diagram. The whole process o f this system is as follows using all the sensors and modules :-

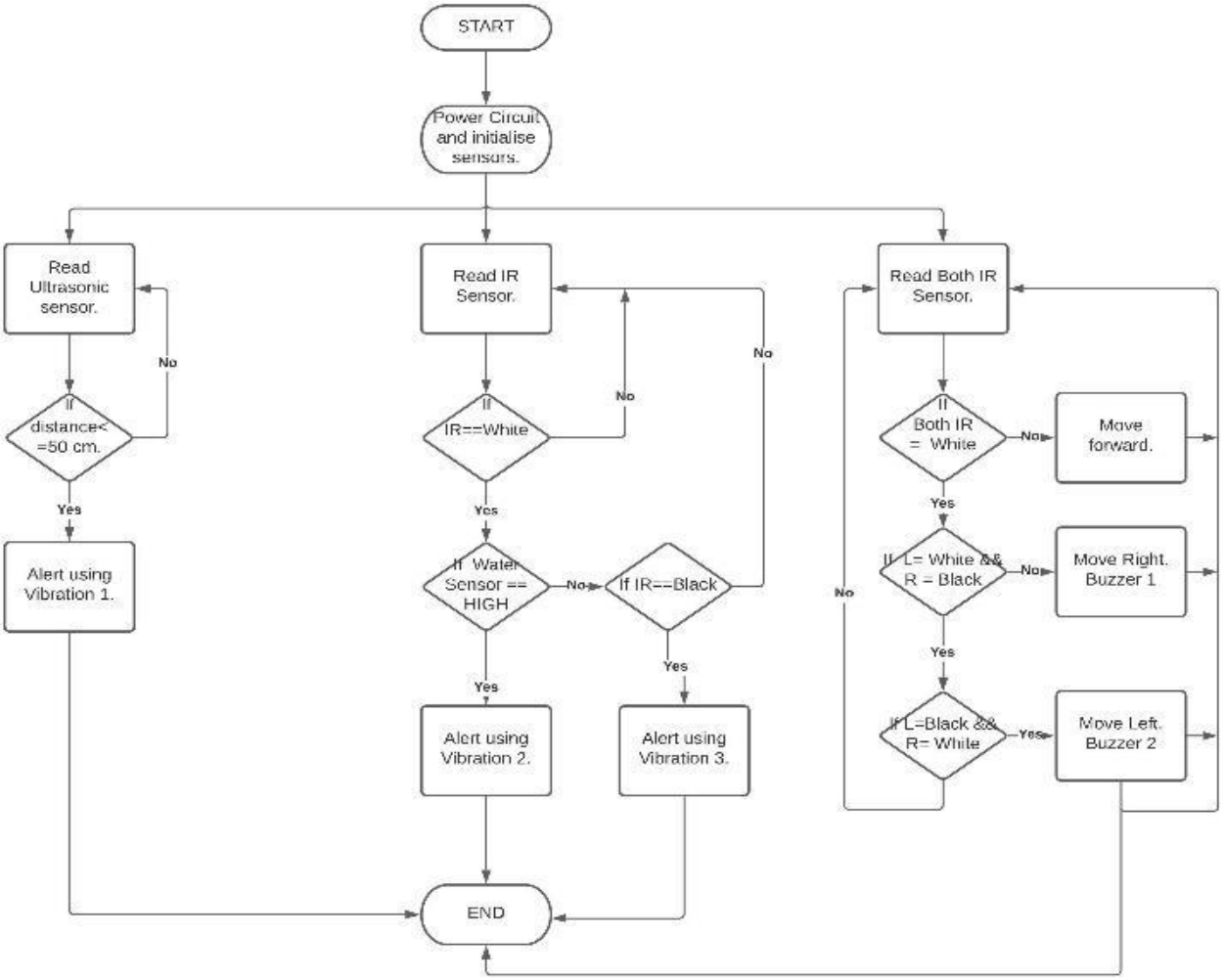

Fig.3- Block Diagram

BLOCK DIAGRAM:-

Tracker Module-
The tracker part consists of GPS Module and GSM Module, which will help send the alert to any preferred person the user wants to contact at the time of emergency. With one push of a switch, the user can alert and ask for help b y providing the exact location of himself outdoors.

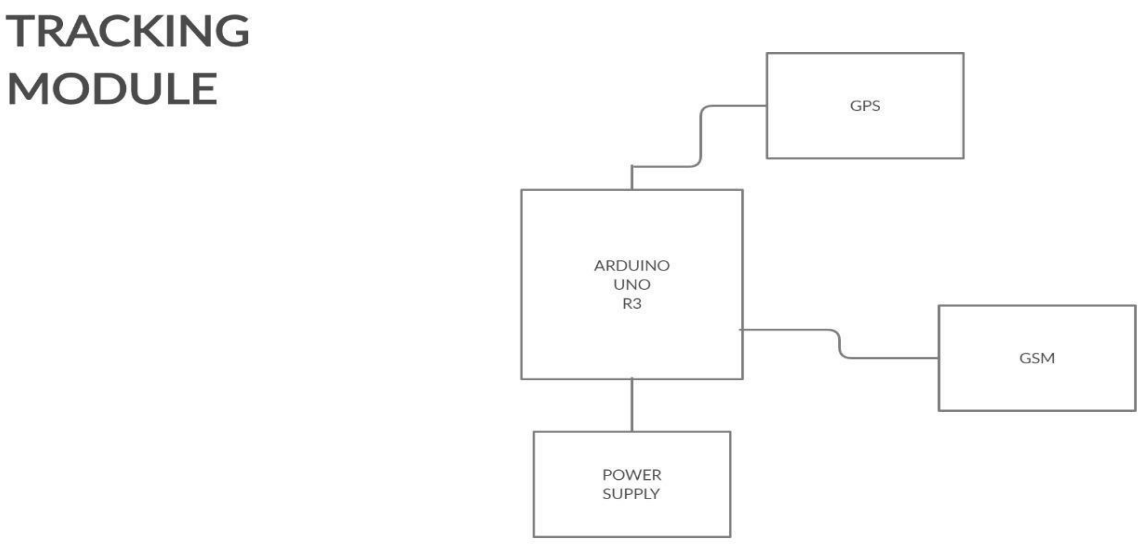

Fig.4- Tracker module[27]

- Microcontroller (Arduino)-

Arduino[18] UNO is the electronic device which contains processing Power, memory and IO ports to inter act with different connected devices. In this system 8 mega 328 IC is the brain of the system which stores t he status of fuel level in a fuel tank and position of a vehicle. The system is powered by DC power supply with proper specifications. This supply can be provided by batteries. Obstacle Sensor will be used to sense the measure of RPM along with a quantity of fuel consumed and notify the microcontroller about the level of fuel in the fuel tank.

Fig.5- Arduino UNO[3]

- GPS Module:-

The Global Positioning System (GPS)[19] is interfaced to the microcontroller to detect the blind person loc ation .The proposed architecture consists of a GPS signal receiver and GSM, vibratory circuitry connected to ARM7. This complete setup will be fixed to stick. The GPS will be sending the location information to t he controller continuously.

Fig.6- GPS Module[5]

- GSM Module:-

The same will be routed to the GSM[20] modem through the controller. GSM will forward this information to the pre fed mobile nos. the user after receiving the message. If the person wants to know the location of the bli nd person, he has to send one message like TRACK immediately he will get the blind person location coordina tes.

Fig.7- GSM Module[5]

- Vibration Motor:-

Vibration motor[21] is a coreless DC Motor and the size of this motor is compact. The main purpose of this motor is to alert the user from receiving the call without sound/vibrating. These motors are applicable for different applications like pagers, handsets, cell phones, etc. The main feature of this motor is, it has m agnetic properties, lightweight, and motor size is small. Based on these features, the motor performance is highly consistent. The configuration of these motors can be done in two varieties: one is a coin model and another one is a cylinder model.

Fig.8-Vibration sensor[21]

Sensor Module-
The sensor part consists of various sensors like Ultrasonic (HC-
SR04) , IR Sensor and Water Sensor, Vibration sensor, which will help detect the upcoming obstacle and also p hysically detect the type of obstacle.

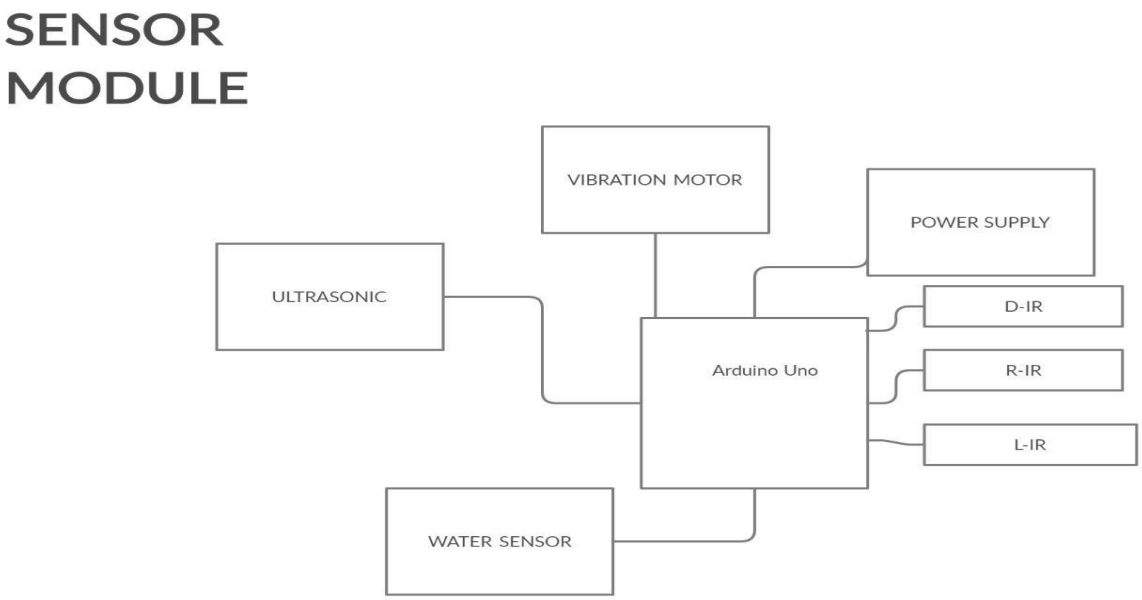

Fig.9- Sensor Module

Ultrasonic Sensor:-

Ultrasonic waves[22] are sounds with frequencies higher than 20 kHz which is not heard by humans. The theor y is based on measuring the pulse reflection time. The ultrasonic transducer transmits a wave pulse and receives a reflection signal called Echoes. When the transmitted wave pulse detects an object, the reflected wave, echo wave, is bounced back to the transducer .

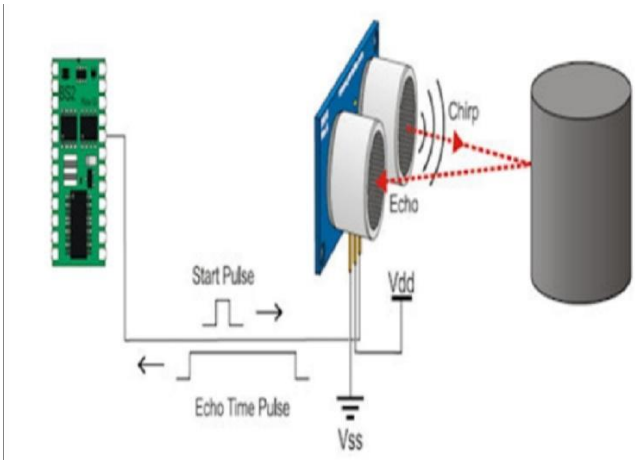

Fig.10- Ultrsonic Sensor[22]

- IR sensor:-

An infrared sensor[23] circuit is one of the basic and yes very popular sensor modules in an electronics device as well as electronics filed. This sensor is analogous to humans' visionary senses, which can be used to detect obstacl es and it is one of the common applications in the real time, this circuit comprises the following components .

- LM358 IC2 IR transmitter and receiver pair
- Resistors of the range of kilo ohms
- Variable resistors
- LED light emitting diode

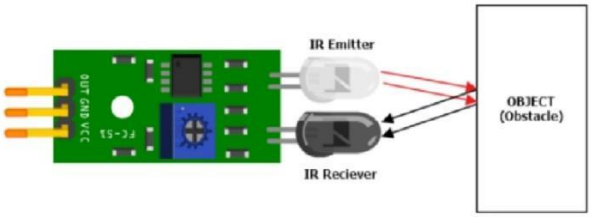

Fig.11-IR sensor[11]

- Water sensor:-

A water sensor [24] is a device used in the detection of the water level for various applications. Water senso rs can come in several variations that include ultrasonic sensors, pressure transducers, bubblers, and float s ensors.

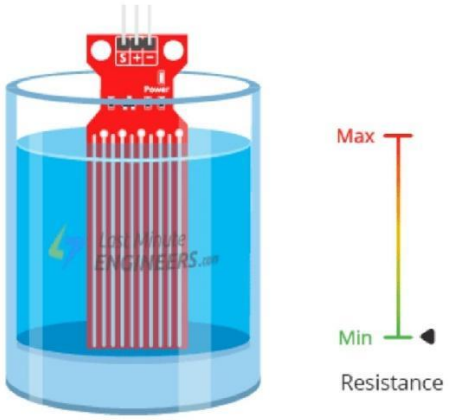

Fig.12- Water sensor[24]

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IV. CONCLUSIONS AND FUTURE SCOPE

In this paper, we proposed and described a fully secured navigation system for blind people. The main advantage of the system is that it can make aware the user about obstacles of left side, right side and f ront side efficiently. We are using both the benefits of walking stick and detection by sensor module to provide complete protection into the environment. We are including walking stick into our system becaus e it is the most common method of walking for blind people so that it is most convenient for them. The proposed system pays more attention to sensor fusion which has been attained by the use of microcontrolle r.

The system is designed considering usefulness of all ages, user friendliness and does not need pre trainin g and knowledge of advanced technologies. The primary objective of this system is to design a cost effec tive and easier to handle even for a visually impaired illiterate person.

The problems experienced with the current system appear to be the infrared sensor as it starts giving blind spots (n o depth values) under strong sunlight. In the future, replacing it with some other depth sensor, such as a laser stripp er, might yield more accurate responses. However, the concept of combining vision with sensed imagery proves to work well. Another problem is with the ultrasonic sensor whose signal reflection or the absorption may result in fal se information. Hoping the limitations of the system will be removed soon and the system would help the blind p ersons.

V. ACKNOWLEDGMENT

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VI. REFERENCES

1. Sainarayanan G., Nagarajan R., Yaacob S. Fuzzy image processing scheme for autonomous navigation of human blind. A ppl. Soft Comput. J. 2007;7:257–264. doi: 10.1016/j.asoc.2005.06.005. [CrossRef] [Google Scholar].
2. Parvanta C, Nelson DE, Parvanta SA, Harner RN. Essentials of Public Health Communication. Sudbury, MA: Jones & Ba rtlett Publ.; 2010. [Google Scholar] [Ref list].
3. Manu Ravi, “Blind Assistant Navigation System”, (DOC) academia.edu, Real Time Embedded Systems.
4. Olakanmi O. Oladayo, “A Multidimensional Walking Aid for Visually Impaired Using Ultrasonic Sensors Network with Voice Guidance”, I.J. Intelligent Systems and Applications, 2014, 08, 53-59 Published Online July 2014 in MECS.
5. M. Naveen Kumar, K. Usha, “Voice Based Guidance and Location Indication System for the Blind Using GSM, GPS and Optical Device Indicator”, International Journal of Engineering Trends and Technology July 2013.
6. B.MohanSitaramaiah, M.Naganaik, “ Electronic Guide Cane with Ultrasonic eyes for Visually Impaired” , International Jo urnal of Advanced Technology in Engineering and Science January 2015.
7. Engineering and Science January 2015 [7] Nandish M S, Mr. ChetanBalaji, Prof. Shantala C P, Mr. ChetanBalaji, “An Ou tdoor Navigation With Voice Recognition Security Application For Visually Impaired”, International Journal of Engineeri ng Trends and Technology Apr 2014
8. V. Kulyukin, C. Gharpure, J. Nicholson, S. Pavithran, “RFID in Robot-Assisted Indoor Navigation for the Visually Impaired”, Proceedings of 2004 lEEE/RSJ International Conference on Intell igent Robots and Systems, September 28 -October 2,2004, Sendai, Japan.

9. B. B. Blasch, W. R. Wiener, and R. L. Welsh, Foundations of Orientation and Mobility, 2nd ed. New York: AFB Press, 1 997.
10. Arjun Sharma, Rahul Patidar, ShubhamMandovara, IshwarRathod, "Blind Audio Guidance System", International Journal of Emerging Technology and Advanced Engineering, volume 3, January 2013,pp.17-19.
11. Roshni: Indoor Navigation System for Visually Impaired by D.Jain and M.Balakrishnan, P.V.M.Rao.
12. Lisa Ran, SumiHelal and Steve Moore, "Drishti: An Integrated Indoor/Outdoor Blind Navigation System and Service", Pr oceedings of the Second IEEE Annual Conference on Pervasive Computing and Communications 2004 IEEE.
13. Shraga Shoval, Johann Borenstein, and Yoram Koren," The navbelt - a computerized travel aid for the blind based on mobile robotics technology",IEEE Transactions on Biomedical Engineeri ng, Vol. 45, No. 11, pp. 1376–1386, 2014.
14. Young Hoon Lee and Gerard Medioni. Rgb-d camera based navigation for the visually impaired. In RSS 2011 RGB-D: Advanced Reasoning with Depth Camera Workshop, pp. 1–6, 2011.
15. Sylvain Cardin, Daniel Thalmann, and Fr´ed´eric Vexo. A wearable system for mobility improvement of visually impaire d people. The Visual Computer, Vol. 23, No. 2, pp. 109–118, 2007.
16. International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 8, August 2015.
17. International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue7- July 2013. Voice Based Guidance and Location Indication System for the Blind Using GSM, GPS and Optical Device In dicator M. Naveen Kumar#1 , K. Usha*2 #M.E Student, *Associate Professor Department of ECE, M.V.S.R. Engineering College, Nadergul, Andhra Pradesh, India.
18. International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 7 Issue III, Mar 2019- Available at www.ijraset.com.
19. Shamsi, M.A.; Al-Qutayri, M.; Jeedella, J.; Blind assistant navigation system Biomedical Engineering (MECBME), 2011 1st Middle East C onference on 21-24 Feb. 2011.
20. Michel Mouly and Marie-Bernadette Pautet: GSM System for Mobile Communications, published by the authors 1992, ISBN 2-9507190-0- 7.
21. Vibrator Motor Working and Applications. Elprocus.com.
22. Process Tomography & Instrumentation System. Ultrasonic Sensor For Distance Measurement .Ayad Ahmed Ebrahim, R uzairi Abdul Rahim, Anita Ahmad,Khairul Hamimah Abas.
23. International Journal of Engineering Research and Technology.Pooja Ajmera Department of Electronics & Communicatio n Vivekananda Institute of Technology, Jaipur Jaipur, India.
24. Editorial Feature. What is a Water Sensor? Written by AZoSensors.
25. A Navigation System for the Visually Impaired: A Fusion of Vision and Depth Sensor Nadia Kanwal,1 Erkan Bostanci,2 Keith Currie,3 and Adrian F. Clark4 1 Department of Computer Science, Lahore College for Women University, Jail Roa d, Lahore 54000, Pakistan 2 Computer Engineering Department, Ankara University, Golbas ¨ ,ı, 06830 Ankara, Turkey 3 Department of Literature, Film and Theater Studies, University of Essex, Colchester, Essex CO4 3SQ, UK 4 School of Co mputer Science and Electronic Engineering, University of Essex, Colchester, Essex CO4 3SQ, UK.
26. The Journal Of Navigation(2013), 66, 349–362. © The Royal Institute of Navigation 2013 doi:10.1017/S0373463312000574. Sensory Navigation Device for Blind P eople L. Dunai, G. Peris-Fajarnés, E. Lluna and B. Defez Universitat Politècnica de València, Research Center in Graphic Technology, Spain.
27. SVS Embedded, svsembedded.com- GPS+GSM Based Smart Blind Stick Tracking System.