Smart Supervisory Stick for Blind Using Raspberry Pi

[1]Vubbara Deekshitha, [2]Pasupulety Sai Teja, [3]Jakka Madhurima, [4]Shailaja P, [3]Pramoda K V

[1]Student, [2]Student, [3]Student, [4]Student, [5]Assistant Professor,
Computer Science And Engineering Department,
Nagarjuna College of Engineering and Technology, Devanhalli, Bangalore- 562 164, INDIA.

Abstract*— Blindness is one the issues over which humans still have no control. It takes away the very right of the person to witness the everlasting visual beauty of the world from one's life. But on the other side, the worries are even more worse, the endless problems faced by them during performing even the simplest of the tasks in day to day life hinders their existence. Being independent is the very right that everyone is born with, which is to live and lead life without being controlled by any action, or acumen from any external factors is rightfully termed as being independent. Traveling is the most dominant problem for people with blindness, for instance during finding a transport, crossing roads, travelling through trains or bus, and it becomes an impossible task to commute through public places. These issues lead to their lack of confidence and even deteriorate their health. With the present technology driven era solution lies in developing a smart stick which enables the people with blindness to ease their problems and help them in carrying out daily tasks. Thus the proposed work presents a smart stick for the people with blindness. It is developed and designed using Ultrasonic sensors, GPS module and has the ability to provide voice command to people through headsets. There by helping the people with blindness to safely navigate through public places independently and helping in carrying out daily tasks.

Index Terms —***Blind Stick, smart Stick, Ultrasonic sensor, obstacle avoider, Raspberry pi.***

I. Introduction

Blindness is a major problem that world is dealing with at present. According to an online survey, around 39 million people are blind, 940 million people have some amount vision loss, while 246 million people had very low vision. Of all the above mentioned cases complete blindness is almost impossible to treat. The effect it has on the person life and mental health is unthinkable [1][2][3]. One of the startling facts is that now Indian is home to the largest number of blind people, of the 39 million blind people around the world, 15 million blind people are from India [4]. India is house to one of the largest eye donations, 2.5 lakhs eyes are donated every year of which only 70% are useable [5]. The problems faced by people with blindness are of very high concern and needs instant solution to this rapidly growing issue. One of the most sought after solution is the development of guidance system for people with blindness. Various devices have been built for the navigation and obstacle identification for the blind. As with the advancement of technologies many variants have been developed. The most common is the Electronics Travel aids (ETA), these devices are usually equipped with navigation and obstacle identification technology. But many of these devices have limited functions and are lack accuracy. Thus to overcome and address the issues of these presently available devices a smart stick using raspberry pi has been proposed. The smart stick is integrated with various sensors and electronics devices which enable the people with blindness in ease of travel and in carrying out their day to day activities.

II. Review of Previous work

It is always necessary to review the work of the researchers done previously to deduce out the problem statement and solution for it. This leads to the development of device which overcomes the problems posed by the earlier ones.

A smart stick has been proposed for the blind in [6]. It uses various sensors to overcome the obstacles, but the limitations are that it can sense only till the stick range. This issue was overcome using echolocation and image processing as proposed in [7]. Where as in [8] [9] [10] [11] a smart stick is build using ultrasonic sensors, buzzer and vibration sensor for travelling and to avoid obstacles.

An Arduino based GPS and GSM enabled smart stick is proposed in [12] [13] which also sends the details of the location to the family in case of emergency. While on the other side various devices have been developed. Table 1 presents the details of different methodologies used in the literature.

TABLE I. Description of different methodologies in Survey

SL. NO	Device Details	Description
1	C-5 Laser Cane [14]	Developed in 1973, uses optical triangulation technology. Has a range up 3.5 Meters
2	Sonic Torch [15]	Uses ultrasound transmitting and is battery operated.
3	Mowat Sensor [14][15]	Uses ultrasonic sensors and tactile vibrations. The distance is inversely proportional to the frequency of vibrations.

4	Sonic Path Finder[14][15]	Uses acoustic difference as main technology. Not accurate
5	Meldog [16][17]	Uses AI technology which rather different from sonic pathfinder. Has ultrasonic and laser sensor
6	Navbelt [14]	Equipped with ultrasonic sensors and computer, has 120° wide view and is converted into series of audio instructions.

III. SYSTEM DESCRIPTION AND IMPLEMENTATION

The proposed system is as shown in Fig. .1 Consists of three main units:

1. Ultrasonic Sensor and Flex Sensor unit.
2. GSM Module unit.
3. Image to Text and Text to Speech unit.

The proposed is developed specifically to aid the people with blindness, thus making it easy to use and maintain. The device is developed using various electronics sensors. It consists of ultrasonic sensors, GPS module, also audio feature is enabled which acts as a feedback. Text to speech (TTS) technology is used for voice command. The device proposed here, first detects an object or an obstacle around it, once detected it then sends the feedback which is in from of speech to the earphone of the user there by providing with location through GPS. The objective of the proposed work is to provide a low cost device with high efficiency and obstacle detection for people with blindness. There by providing the user with artificial vision, which provides them with details on the surrounding environment, like static and dynamic object around them, hence helping the people with blindness to walk independently.

There are four ultrasonic sensors which has been incorporated in the system i.e. smart guiding stick. These are electronic sensors. To improve efficiency of the smart stick compared to previous versions, three sensors are on both the sides of the sticks. Pothole detection is one of the important features of the proposed work, thus one of the sensors is placed below the smart stick. Range of these sensors vary from 2-250cms. Identification object and text is done through camera. To change and vary the different features of smart stick a toggle switch is provided. Finally, the text is converted speech command and fed into earpiece to be heard by the user.

A. Ultrasonic Sensor

Ultrasonic sensor is a device which generates sound waves at very high frequency. The distance is calculated based on the sound waves received back. The calculation of the distance is based on the time interval between the sending and receiving signal by the sensor.

B. GSM Module

Navigation of the user from source to destination is main function of the module. Obstacle detection is the first step, the distance between the obstacle and the user over the voice command is initiated using ultrasonic sensor after which the navigation details are sent as voice command to the user through earphone. Latitude and longitude based location technology is used. The details are stored for directions.

C. Camera Module

Object identification and text reading is captured through a Logitech high resolution C series camera. Digital image processing is used for conversion of captured image. This particular camera is used as it is ideal for high definition image capturing with 1080 pixels HD quality and a premium glass lens.

D. Ear Phones

It is used as output of the TTS, such that it enables the person with identification of object, text and pothole detection.

E. Flex Sensor

The amount of deflection or the bending is detected using the flex sensor. When the sensor is struck to the surface, the resistance of the sensor gets varied by the bending surface. As the resistance is directly proportional to the amount of bend, it usually used as goniometer and known as flexible potentiometer.

F. Raspberry Pi Protocol Architecture

A raspberry is basically a type of low cost and high on performance computer. It can be connected to a TV and PC Monitor which helps it to be used a computer. Fig.2 below shows the Raspberry Pi architecture.

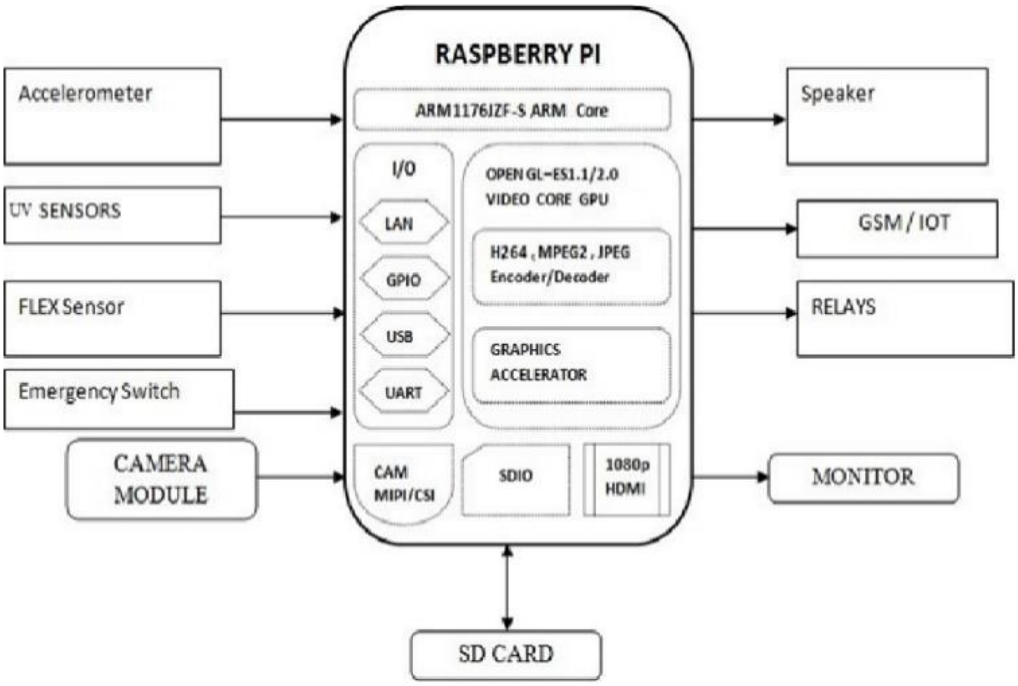

Figure 1 Block Diagram of the proposed System

1. It has a 700Mhz single core CPU
2. There are four USB ports
3. It is built with dual core video IV multimedia processor
4. It has a RAM of 512 mb
5. For storage of data, a micro SD slot is provided
6. It a 3-watt device.

In the proposed work, raspberry pi acts as the computer of the smart stick. It is low cost computer, and credit card sized. The input to is taken from the GPIO pins, thus in turn it can be attached to LED's, switches, analog signals and other devices. Here the GPIO pin are connected to the ultrasonic sensors. Raspberry Pi is powered using 5V supply and for storing data a micro SD Card is used. Here a Raspberry Pi 1 Model B+ has been used. It consists of four USB ports, HDMI port, an audio jack and an Ethernet port. To install the required driver APIs, Ethernet port is used to connect to the internet.it is built-in with 700MHz single core processor, the device can support programming languages like Python, Java, C, and C++ etc. Thus algorithm for the proposed work is executed using Raspberry Pi. The algorithm helps us in calculating the distance from the obstacle using the sensors. Once the distance is calculated the text to speech (TTS) driver API is used which converts the message in text format i.e. the distance to speech and delivered to the user through earphone.

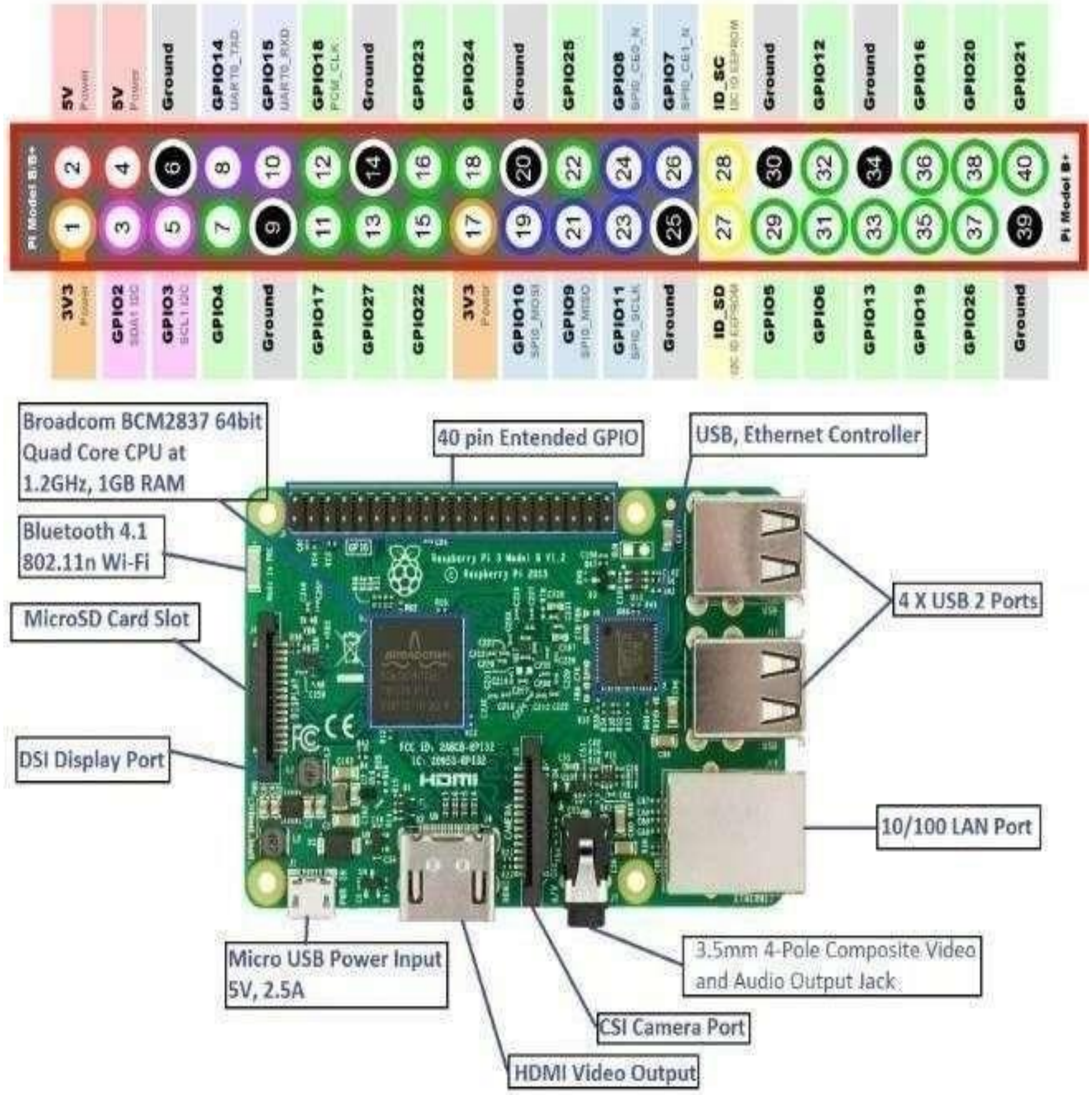

Figure 2 Architecture of Raspberry Pi

G. Flow Chart of proposed architecture anticipation:

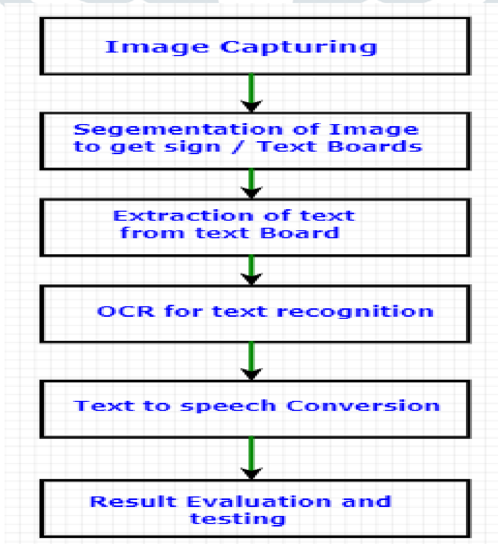

Figure 3 Flow chart the Smart Stick

It basically describes the sequences of operations that takes places with respect to the project as shown in the Fig. 3 Our project striking feature would be the image capturing for reading a particular text. The flowchart starts with capturing an image that the blind wants to read. Segmentation of the image takes place in order to retrieve the text from the image, which then makes use of the sign board to get the text identified. Extraction of the text from the text board converts the image to the text that the blind will want to read. We make use of OCR for the text recognition. This text is then converted into speech or audio which helps the blind person to read anything he desires. This feature keeps the bind informed with respect to the surrounding.

H. Activity Diagram

The Fig. 4 below explains all the features in our project. Our project mainly concentrates on the blind and his safety. we make use of raspberry pi in order to achieve all the features stated. The use case highlights on the image to text and text to voice conversion, this feature is used in order to read anything that blind wants as the text will be converted to voice which the blind can hear.

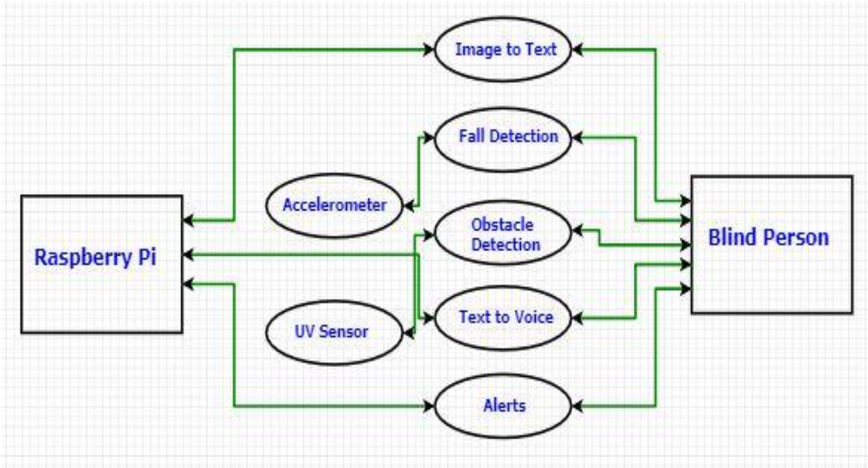

Figure. 4 Activity Diagram

It also explains features such as obstacle identification with the help of UV sensor. One important and last feature to be included would be the fall detection where an intimation would be given to the care taker through a message or email by using the accelerometer. We would use all methods involved in order to maintain safety with the mobility of the blind. The data flow diagram is as shown Fig. 5 below.

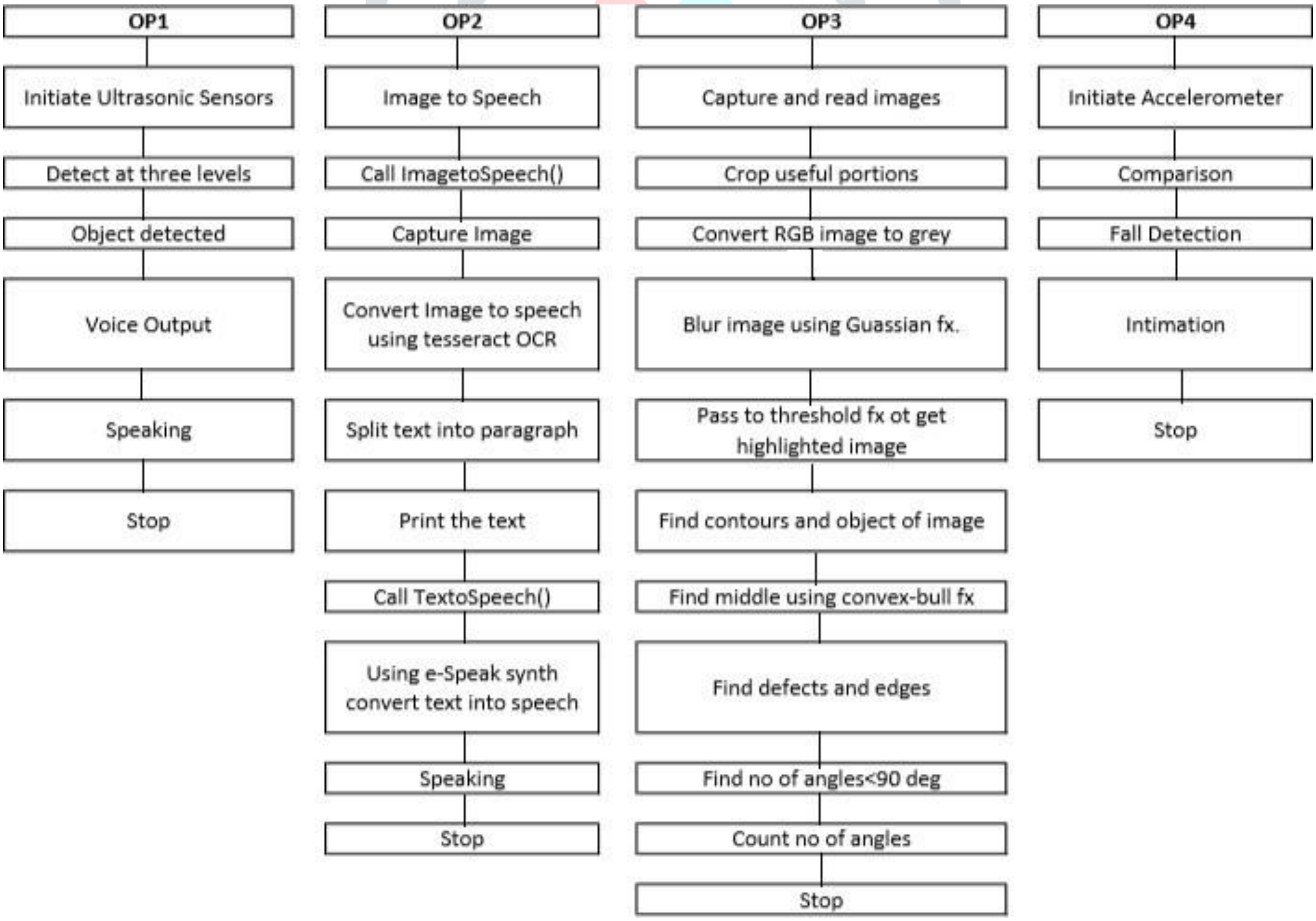

Figure. 5 Data flow Diagram

IV. RESULTS AND DISCUSSION

Testing and validation of the developed prototype is very important, as it helps in the cementing the results of the proposed work. This section presents the hardware test results of smart stick. It is done using two methods namely:

1. Unit Testing
2. System Testing.

It is a type of software testing, normally for individual components and units of software are tested. One of the main reason to perform the above mentioned testing is to check the validity of each unit of software, if they perform as designed. In the proposed work, raspberry pi is being tested for its compatibility with ARM processor as shown in the below Fig.6. The output is indicated through the working LED's. Table 2 shows the unit results of different components under test.

Figure. 6 Testing the connection with Raspberry Pi

TABLE II – UNIT TESTING OF COMPONENTS

Module No	Module Name	Observation	Expected Result	Actual Result
1	Obstacle detection	If the obstacle is within 20cm	Obstacle detected	PASS
2	Obstacle detection	If the obstacle is beyond 20cm i.e 50cm	Obstacle not detected	FAIL
3	Fan automation	The flex sensor bent at 180 degree ,the fan will switched on	fan will switched on	PASS
4	Fan automation	The flex sensor not bent properly i.e 45 degree	fan will not switched on	FAIL
5	Image processing	Image need to be captured at a clarity	Image captured	PASS
6	Image processing	Image is not captured at a clarity	Image not captured	FAIL

System testing is usually done to ensure the operating system of the device under test is able to under different environments. It is mainly done after the system is fully integrated. System testing falls under the category of black box testing. Once the integration of all the modules are done, the input are initiated. It is carried out to detect any kind of mismatch in software or output. Sometimes there are problem between the unit's integration which leads to damage to device. Thus system testing helps in finding the defects between the "inter-assemblages and also within the system. The output of the systems testing defines the actual working of the device. System testing are performed on whole system to check the functionality of the system not only within the bounds of the software but also the hardware requirements of the proposed system. As shown below Table 3 shows the test results of the hardware test performed on the device.

TABLE III .Blind stick Functionality Test Results.

Module No	Module Name	Observation	Expected Result	Actual Result
1	Blind stick functionalities	All things are working	Image should be captured, fan automation should work, Obstacles are detected	PASS

The hardware prototype is as shown in Fig. 7, here each module is tested for compatibility, once system integration is done. As can be seen from the Figure shown below, Raspberry Pi is tested with ultrasonic sensor and headphone for speech recognition.

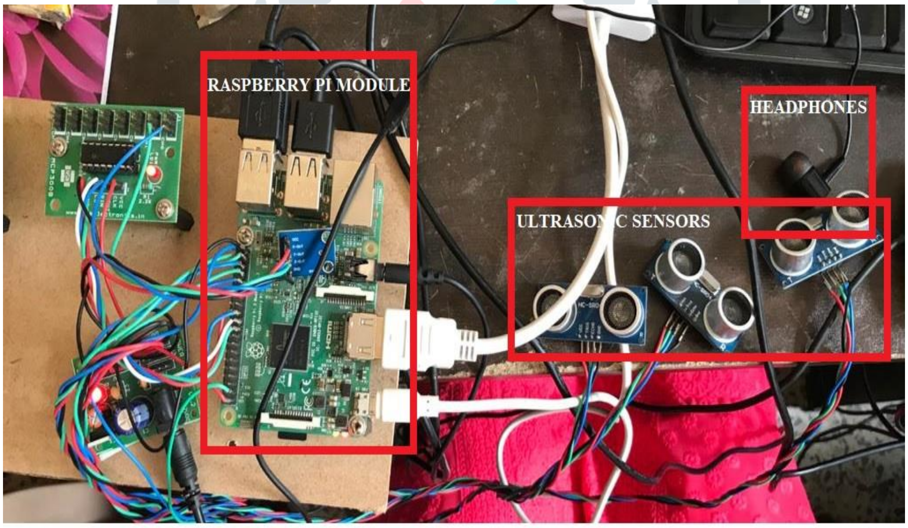

Figure. 7 Hardware prototype being tested

Image to speech conversion is one the highlights of the proposed work, Fig. 8 presents the validation of Image to speech conversion, as can be seen from the Figure shown below, the image is being captured using a high resolution camera and converter to speech which made audible to the user using ear piece. Distance is the most important factor which is considered in devices for blind. The accuracy of the device depends on the distance range the sensor can predicted and the sensors are tested for 360° accuracies as can be seen from the below shown Figure.8.

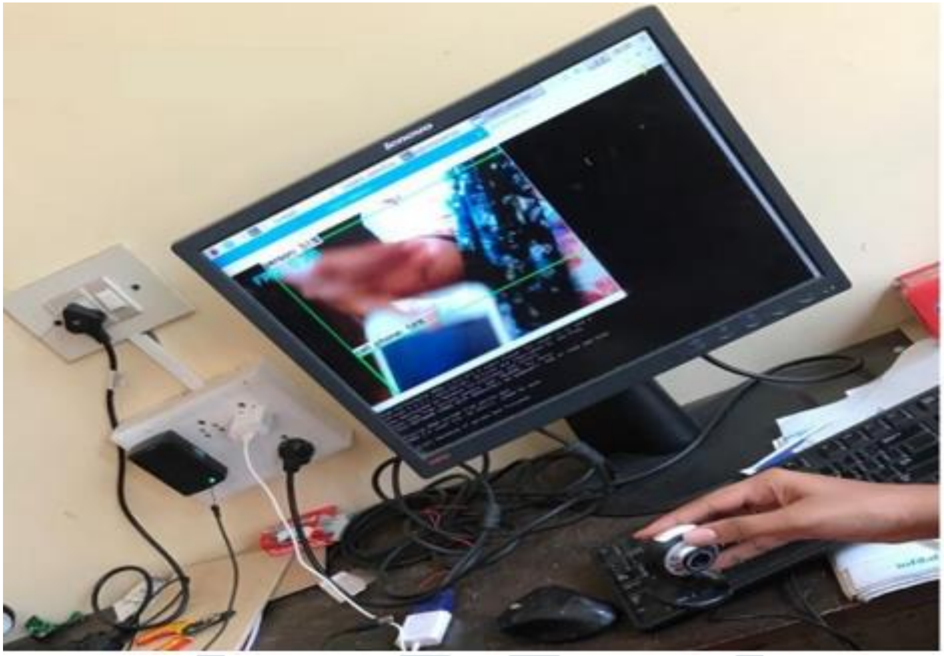

Figure 8 Image to text conversion

CONCLUSION

The proposed work titled "Smart guiding Stick for Blind Using Raspberry Pi" is presented here, the system is built using various electronic sensors to improve the efficiency of the device which was one of the major concern in previous works as presented in review section and mitigating the faults present in the previous system. The device is designed using Ultrasonic sensors, GPS module, high resolution camera which in turn is converted to speech using TTS technology hence the user is provided with Voice command which sent via headphone to the people with blindness. Thus helping the person with blindness to navigate through any place independently. The system is a combination of electronic sensors like ultrasonic and GPS which tracks and provides real-time location of the user and navigation to the user from source to the destination. Thus in a nutshell the proposed system is efficient and economic which would assist the people with blindness in their day to day activities enabling them to be independent.

REFERENCES

[1] http://www.who.int/mediacentre/factsheets/fs282/en/
[2] http://www.who.int/mediacentre/factsheets/fs282/en/
[3] https://www.iapb.org/vision-2020/who-facts/
[4]https://timesofindia.indiatimes.com/india/India-has-largest-blindpopulation/articleshow/2447603.cms
[5] http://www.myeyeworld.com/files/eyebanks.htm
[6] Ayat A. Nada, Mahmoud A. Fakhr and Ahmed F. Seddik "Assistive Infrared Sensor Based Smart Stick for Blind People", Science and Information Conference (SAI), 2015, 10.1109/SAI.2015.7237289
[7] https://en.wikipedia.org/wiki/Water_detector
[6] Mukesh Prasad Agrawal, Atma Ram Gupta," Smart Stick for the Blind and Visually Impaired People",Department of Electrical Engineering, National Institute of Technology Kurukshetra, Kurukshetra, Haryana, 136119, India. Date of Conference: 20-21April 2018. Date Added to IEEE Xplore: 27 September 2018.
[7] Akhilesh Krishnan, G Deepakraj, N Nishanth, K. M. Anandkumar, "Autonomous walking stick for the blind using echolocation and image processing", Department of Computer Science and Engineering, Easwari Engineering College, Chennai, India.Date of Conference: 14-17 Dec. 2016.Date Added to IEEE Xplore: 04 May 2017
[8] Ayat A. Nada, Mahmoud A. Fakhr, Ahmed F. Seddik," Assistive infrared sensor based smart stick for blind people", Department of Biomedical Engineering, Faculty of Engineering, Helwan, University, Cairo, Egypt. Date of Conference: 28-30 July 2015.Date Added to IEEE Xplore: 03 September 2015
[9] Himanshu Sharma, Meenakshi Tripathi, Amit Kumar, Manoj Singh Gaur, "Embedded Assistive Stick for Visually Impaired Persons", Dept. of CSE, IIT Jammu, Jammu, India. Date of Conference: 10-12 July 2018.Date Added to IEEE Xplore: 18 October 2018
[10] Ahmed El-Koka, Gi-Hyun Hwang, Dae-Ki Kang," Advanced electronics based smart mobility aid for the visually impaired society", Division of Computer and Information Engineering, Dongseo University, Korea. Date of Conference: 19-22 Feb. 2012. Date Added to IEEE Xplore: 03 April 2012.
[11] Zeeshan Saquib, Vishakha Murari, Suhas N Bhargav," An invisible eye for the blind people making life easy for the blind with Internet of Things (IoT)", ECE Dept, BNMIT, Bangalore.Date of Conference: 19-20 May 2017. Date Added to IEEE Xplore: 15 January 2018.
[12] K. B. Swain, R. K. Patnaik, S. Pal, R. Rajeswari, A. Mishra and C. Dash, "Arduino based automated STICK GUIDE for a visually impaired person," 2017 IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM), Chennai, 2017, pp. 407-410.

[13] A. S. Arora and V. Gaikwad, "Blind aid stick: Hurdle recognition, simulated perception, android integrated voice based cooperation via GPS along with panic alert system," 2017 International Conference on Nascent Technologies in Engineering (ICNTE), Navi Mumbai, 2017, pp. 1-3.
[14] Johann Borenstein and Iwan Ulrich, The Guide Cane- A Computerized Travel Aid for The Active Guidance Of Blind Pedestrians, IEEE International Conference on Robotics and Automation, Albuquerque, NM, Apr. 21-27, 1997.
[15] Zul Azizi Hailani, Sakinah Jamaludin, "An Electronically Guided Walking Stick For The Blind University Tenaga Nasional, Malaysia
[16] Sung Jae Kang, Young Ho, Kim, In Hyuk Moon, "Development Of An Intelligent Guide-Stick For The Blind", IEEE International Conference on Robotics & Automation Seoul, Korea, May 21-26, 2001.
[17] Susumu Tachi, Kazuo Tanie, Kiyoshi Komoriya, Minoru Abe, "Electro cutaneous Communication In A Guide Dog Robot (Meldog",IEEE Transactions on Biomediacal Engineering, 7 July 1985.