

Virtual Eye for the Blind - A Smart Guiding Device for the Blind

Dr.A.N.Jayanthi¹, M.Karthigeyan², C.Jotheeswaran³, M.Logeshkumar⁴

B.E Final year, Department of ECE, Sri Ramakrishna Institute Technology, Coimbatore, India^{2,3,4}

Associate Professor, Department of ECE, Sri Ramakrishna Institute Technology, Coimbatore, India¹

ABSTRACT: Vision is a Wonderful gift given by the God for the human beings. Vision allows people to understand the surroundings. Till date blind people struggle a lot to live their own life. In the presented work, a simple, cheap, friendly user, virtual eye is designed to improve the mobility of visually impaired people in a specific area. The presented work includes a wearable equipment consists of glove to help the blind person to navigate safely and to avoid any obstacles, and to prevent any possible accident. This project helps blind people to map their world using the sense of hearing. The system utilizes two types of devices including sonar sensor and camera which is placed in the glove. A microcontroller processes the reflected signals from all devices in order to classify front obstacle. This system can be faster when compared to other. The system provides affordable and comfort solution and also helps the impaired people to be highly self-dependent. The input of the project will be an image/video (multiple frames), the image captured and analysed with the help of the camera interfaced to the raspberry pi technology. Hence the object is detected and audio information is conveyed to the blind person through earphones. This system deals with an approach to make better life for blind people as it well equipped with the latest technology and it is meant to aid the visually impaired to live a life without constraints.

KEYWORDS: Raspberry pi, Camera, Earphone.

I. INTRODUCTION

According to the world, the number of people of all ages who are visually impaired is estimated to be 285 million, of whom 39 million are blind. Imagine walking into an unfamiliar place, One has to ask for guidance in order to reach to the destination. But what will happen if the person is visually impaired Person and they has to completely depend on other peoples for there locomotion. Due to this they can not move independently. Accordingly, they need to use some tools and techniques to help them in their mobility. One of these techniques is mobility specialist who helps the blind people and trains them to move on their own and safely depending on their other senses. Another method is the guide dogs which are trained specially to help the blind people and the dog guides the visually impaired for there movement. However, in the above mentioned method has some disadvantages such as difficulty to understand the complex direction by these dogs, and they are not suitable in many unfamiliar situations. The method of using dogs need some care to maintain them which is cannot be done by the blind people. There is also a method of using white cane with red tip, but it is not accurate to detect the objects. Generally visually impaired person uses the white cane for there locomotion. The walking cane is a simple and its a mechanical device that dedicated to detect obstacles on the ground, uneven surfaces and holes. But most of the times this cane is not helpful for the blind. Though this device is light, portable, it is not usable for dynamic obstacles detection. Since this device is range limited, we cannot use it for long range detection.

In order to help the blind and visually impaired, this work proposes a simple electronic guidance which is configurable and efficient which is held in the glove. The system utilizes two types of devices including ultrasonic sensor and camera which is placed in the glove. A raspberry pi 3 model B+ microcontroller processes the reflected signals from all devices in order to classify an obstacle. The proposed guidance system is able to determine the obstacle distance. Hence the object is detected and audio information is conveyed to the blind person through earphones. Furthermore, the system can name some of the detected objects. Moreover, neither cane nor other marked tools are needed to be carried by the user. Like other systems, the proposed system can be fasten to a hat or to a pen-sized hand mini stick. It has high immunity to both ambient light and object's colour.

II. LITERATURE SURVEY

There are some systems which has some deficiencies.

Shoval et. al developed a Navbelt, an obstacle avoidance wearable portable computer which is only for indoor navigation. Navbelt was equipped with two modes, in the first one the system information was translated to audio in different sounds. One sound for free for travel direction and other for blocked, it was difficult for the person to differentiate the sounds. Other problem was the system would not know the user momentary position.

D. Yuan et al. have discussed about the virtual white cane sensing device based on active triangulation, that can measure distances at a rate of 15 measurements/second. A blind person can use this device for sensing the environment, pointing it as if it was a flash light. Beside measuring distances, this device can detect surface discontinuities, such as the foot of a wall, a step, or a drop-off. This is obtained by analysing the range data collected as the user swings the device around, tracking planar patches and finding discontinuities.

Benjamin et al. introduce a laser cane with three photo diodes and three laser diodes function as receiver making an optical triangulation. The laser cane detects the obstacle in three different directions. One is 45° to the ground for overhanging obstacles, the second one is parallel to the ground and third one is for sharp deepness. The laser cane has no system for determining location and position. J. Na proposed an interactive guide system for indoor positioning, which cant detect the obstacles and hurdles. The system is not suitable for the outdoor activities.

S. Innet and N. Ritnoom have introduced a stick for distance measurement using infrared sensors, which is a complex and time wasting process. The stick has different vibration modes for different range which is difficult for a blind to differentiate, it needs time for training. The stick informs the person clearly at dangerous stage which conveys less information and safety. The stick has no location and positioning features.

Evangelos Milios et al. have presented a device that allows three-dimensional (3-D) space perception by sonification of range information obtained via a point laser range sensor. The laser range sensor is worn by a blindfolded user, who scans space by pointing the laser beam in different directions. The resulting stream of range measurements is then converted to an auditory signal whose frequency or amplitude varies with the range.

J. Borenstein and Y. Koren have discussed the VFH method which uses a two-dimensional Cartesian histogram grid as a world model. This world model is updated continuously with range data sampled by on board range sensors. In the first stage the histogram grid is reduced to a one- dimensional polar histogram that is constructed around the robot's momentary location. In the second stage, the algorithm selects the most suitable sector from among all polar histogram sectors with a low polar obstacle density, and the steering of the robot is aligned with that direction.

Sylvain Cardin et al. have presented an obstacle detection system for visually impaired people. User can be alerted of closed obstacles in range while traveling in their environment. The system we propose detects the nearest obstacle via a stereoscopic sonar system and sends back vibro-tactile feedback to inform the user about its localization.

III. EXISTING METHODOLOGY

The existing system consists of the devices or the supports like white cane for helping them to detect the obstacles and travel to places, pet dogs and Smart devices like vision a torch for blinds. But, there were many limitations and problems in this existing system like in the white cane, it may easily break or crack and once if we lost the cane then it will be difficult for the blind person to find. The white cane may get stuck at the pavement cracks of the different objects. Whereas the pet dogs cost is huge and need a lot of training.

In case of blind person, it is painful that he cannot see but he tries to ask and get realization of locality and put it into memories when he moves around by sensing the noises and some pick point he understood the situation/locality. If by mistake he removes the kept memorized tag from his mind he cannot realize the locality and he got confused and has to ask his fellow or other moving persons for assistance. Similar case is about direction finding for moving. It clearly shows that any persons/whether impaired or not person keep memorizing the locality information and sense tags in to memory and recover it when they wants to moves around. Literature analysis shows that there are mainly three technologies are used to work in context with similar objective for blind. They are mainly mentioned as below:

- (1)GPS
- (2) RFID information grid
- (3)Mobile platform devices

Let us discuss about above one by one.



GPS: Global positioning system uses longitude and latitude calculations to find out the position of object. Since it uses geospatial satellites signals, to calculate the positional difference, the accuracy is quite in the range of 100m to 300m. For the person who is on outdoor can receive these signals, but for indoor it is very hard to receive the same signal. Also the accuracy required is not gained, hence it is a void solution for blind person to use for navigating device.

RFID information grid: It is Radio Frequency Identification Device. It holds the unique information such as number or symbol or text or id etc. It is passive device which is energized by interrogators EMF field. To form a grid the RFID tags are arranged in such a way that it could describe the longitudinal and latitudinal position. The searching device enquires about the positional information and sends it to server by SMS. The server holds database with relational description of local position for reference send by SMS. It search in database for same and broadcast it on FM which could be heard by the enquirer's device. The big issue To design RFID based cognition device for assisting to the Blind and Visually Challenged Person for Indoor use in system is that the SMS sending and delivering time. Again the air calls traffic congestions. The personal device may work properly but server failure detection case cannot be detected and solved. Hence addressed solution is more of problems than the solution. The two three device on different location should work in same tune with single fetched query which is not viable. The same about remaining technological solutions, they are combinations of two or more type of technical mix hybrid device. The RFID grid system with an RFID reader integrated into the user's shoe and walking cane with Bluetooth connection to the user's cell phone for there safety.

Mobile Platform Devices: Mobility is one of the major problems faced by the blind in their life. The blind and visually impaired people have used some methods and devices such as the white cane and guiding dogs, to help in mobility and to increase safety and independent travel. Due to the development of modern technologies, many different types of devices are now called as electronic travel aids. Among these aids there are sonic pathfinder, Mowat Sensor and Guide cane which are called clear path indicators or obstacle detectors in which the blind can only know whether there is an obstacle in the path. These devices are used to search for obstacle in front of the blind person and they operate in a manner similar to a flashlight. which has very narrow directivity. Sonic-sensor since it has wide directivity it to search for several obstacles at the same time. Portability, low cost, and above all simplicity of controls are most important factors which govern the practicality and user acceptance of such devices. The electronic travel kit is a kind of portable device. Hence it should be in small size and lightweighted device to be proper for portability. As the blind is not able to see the display panel, control buttons, or labels. Hence the device should be easy to control. There should be no complex control buttons, switches and display panel should be present in the aid. Moreover, the ETA device should be of low price and cost efficient to be used by more blind persons.

IV. PROPOSED METHODOLOGY

In order to overcome the difficulties in the existing method and to provide the cost effective and user friendly system for blind navigation, the following design is proposed.

The system designs consider the following hardware components:

- Raspberry Pi 3 model B+
- Ultra sonic sensors
- Camera module
- Earphone

The system design considers the following software components:

- Python programming language Raspberry Pi operating system and programming platform

The whole system is controlled by Raspberry Pi microcontroller. The prototype uses ultrasonic Sensors and a Camera module which helps the system to gather the required data. Python forms the heart of the system. It is used to program the whole system which helps the raspberry pi microcontroller to communicate with all the sensors. It then processes the collected data and converts it into information which is finally delivered to the end user. The Ultrasonic sensors get the data about the distance of the object at regular intervals. Camera module plays an important role as it captures the object in real time which processes using image processing technique to properly identify the object. All the information is processed and converted to audio.

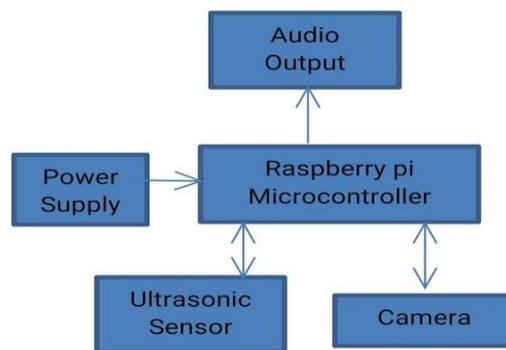


Figure 1: Block diagram

The camera is considered the eye of this system. Camera module plays an important role as it captures any object in real time which is sent to the raspberry pi microcontroller. The raspberry pi microcontroller takes those real time coordinates and processes

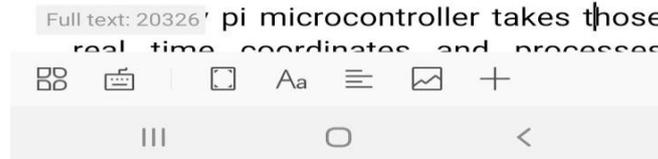


Figure 1: Block diagram

The camera is considered the eye of this system. Camera module plays an important role as it captures any object in real time which is sent to the raspberry pi microcontroller. The raspberry pi microcontroller takes those real time coordinates and processes them using image processing algorithms and generates a corresponding response. And the result is heard using earphone. Python program is used to get the input from camera and ultrasonic sensor. Then, it shows the output on the screen as a text. Text is enabled to audio output which goes directly into the user's ears. Ultrasonic sensor is placed in the glove. This inclination of 30 degrees helps ultrasonic sensors to scan for the objects placed on ground near the user. Hence, they can be used to calculate the distance from an object lying on the ground near legs of the user. These sensors send the data to raspberry pi which in turn processes the data and send the audio output to the user. This full process keeps going simultaneously and continuously until the user decides to switch off the device.

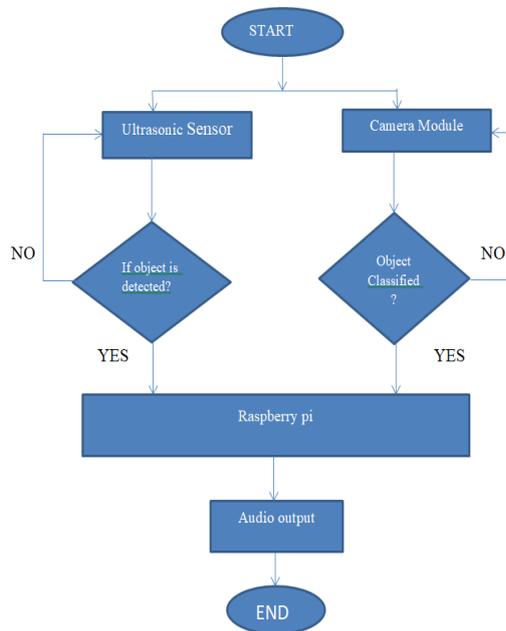


Figure2:Flow diagram

V. RESULTS AND DISCUSSION

The virtual Eye, a Navigation System for Blind is developed and integrated as per the design documented in this section. The system is implemented using raspberry pi, Ultrasonic sensors and camera as the hardware base, python is used to program the hardware and run the object detection model with python. And Raspbian software is used with OpenCv.

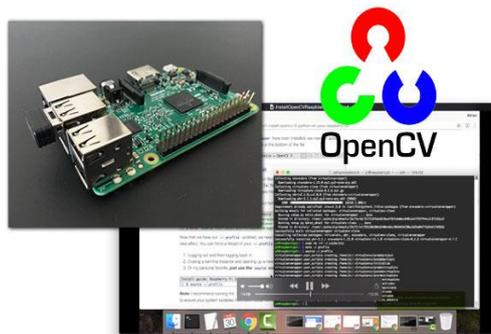


Figure3:OpenCv

Implementation The system is composed of two different components namely: Ultrasonic sensor and camera. All the data from these components is sent to raspberry pi which processes it and gives the output to the user. The features of the system include:

- Detect the distance of the object
- Detect the type of the object
- Convey the output to the user through headphones.

The following sections elaborate the complete process.

Detect the distance of the object

The Ultrasonic sensor gets the distance using sound-waves after the wave hits any object and bounces back. It is capable of calculating distance every second. However, in this work, the system is configured to calculate the distance every three seconds, due to the simultaneous running of other components. Ultrasonic sensor in the circuit is shown in the Figure 4.



Figure 4: Ultrasonic Sensor

The output of the Ultrasonic sensor can be seen in real time on the screen with the actual distance value from the object. The output is shown in Figure 5.

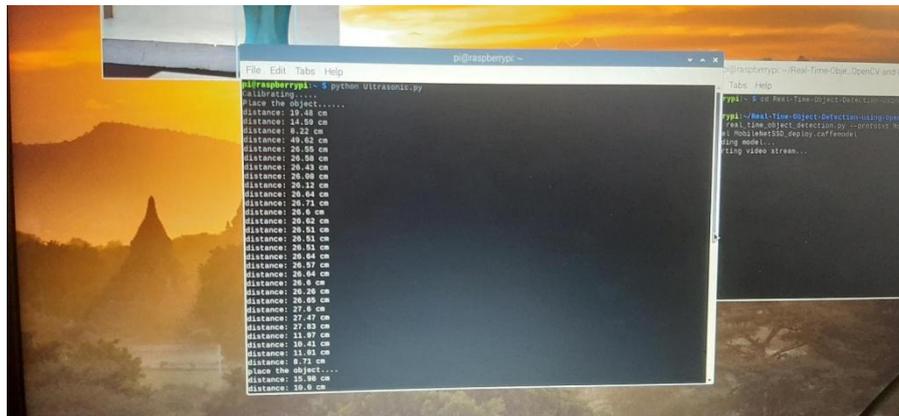


Figure 5: Ultrasonic Output

The above output screen shows the distance of the user from the object in every three seconds. At the same time, this information is being processed by the raspberry pi and being transmitted to the user through earphones. This guides the user about the position of the object.

Detect what is the object

This is one of the most important parts of the system. In order to detect what is the object, the system needs object detection algorithm to run on. This system uses OpenCv for the model and the backend anypython to connect to the model and to run everything in the front end. The algorithm works on caffemodel which is locally stored on the raspberry pi. When the program is running, python connects with the model and starts taking the video. Then, the objects captured in the video are compared with the model and the closest match is shown on the screen and sent to the headset. Currently, the system can detect up to 20 types of objects which are sofa, table, chair, bottle, TV-monitor, aero-plane, train, person and dog. The system is compatible with raspberry pi camera module as well as USB cameras. Figure shows the camera in the circuit.



Figure 6: Camera

The output of object detection can be seen in real time on the screen with the object name as shown in Figure 7.

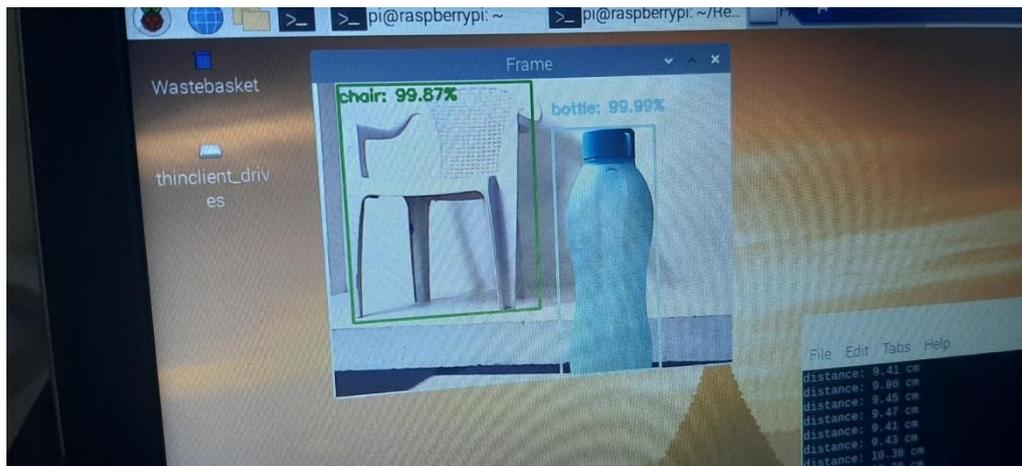


Figure 7: Object Detection Output

VI. CONCLUSION

In this paper, a new navigation system for the blind person has been proposed and developed. The system helps blind and visually impaired people to be highly self-dependent by assisting their mobility regardless of where they are outdoor or indoor. Results show that all the sensors work properly and give accurate readings.

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