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Voice Navigation Based guiding Device for Visually Impaired People

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Abstract— **Navigation of visually impaired people is one of the important disputes that requires significant research consideration. The visually impaired users generally use white canes for obstacle detection by remembering all the familiar locations. In a new-fangled and unacquainted environment, they totally depend on individuals passing by to enquire for certain places. In this contemporary world along with various sensors, there should be a system with the most basic invention to make their life a bit tranquil. A contactless, hands free, LVU (Lidars and Vibrotactile Units), discrete wearable device was designed in this proposed work that allows blind people to detect obstacles. To provide a safe mobility for the impaired people, a suitable mobile assistance device is necessary. This paper propose a safe wearable device with audio output for benign local navigation in both inside and outdoor environment which help in assisting the user to discriminate free space from obstacles. The device presented is composed of wearable strap with sensors. By using TOF sensor attached in the front of the belt worn by the users, the pulses from the LiDAR provide a reliable and correct measurements of the distances between the handler and obstacles. The image captured by the camera is processed and classified by the convolution neural network algorithm. The identified image is given as an audio input to the audio jockey. The vibratory motor and voice intimation by audio jockey provides the haptic feedback when the disabled person reach the obstacle. The vibration motor is placed with a pretension point-loaded applicator to transmit the isolated vibrations to incapacitate person. Distance between the obstacle and the disabled person is measured by using LiDAR sensor and it will be given as a feedback to the visually impaired person with the voice input. Thus, this wearable device helps in assisting the visually impaired people in a more comfortable way than white canes.**

Keywords—LiDAR Sensor, Obstacle Detection, Mobile assistance device, Blind people assistance device.

I. INTRODUCTION (*HEADING 1*)

The blind people face difficulties when they want to move or walk from one area to another. They use white cane as a physical assistance when they want to move from place to place. According to World health organization (WHO) here are 285 million visually-impaired people [5]. The system and service provided by the device which help the impaired people to have safe navigation comes under the term called assistance technology. Research is going on to identify suitable method for navigation in indoor and to identify the samples / object in front of the visually impaired people.

A broad review of assistive technologies for the visually impaired people are invasive and bulky covered with output devices such as braille displays for the feet, fingertips, wrists, forearms, tongue [9]. Even though these tactile devices in vests and belts has audio output representation, it was very bulky and it did not provide any information about the local obstacles, not providing haptic feedback and it was not tested in real time with visually impaired peoples. A broad literature survey among portable, wearable obstacle detection and avoidance systems is analyzed qualitative-quantitative to evaluate its performance measures[10].

Vela´zquez discusses the various mobile assistance device for blind which is worn in the feet, the finger, hands, forearm, tongue, head wrist, and abdomen. The device proposed is especially for blind person in reading and mobility. A review by [12] described RGB- D cameras based assistive computer vision technologies for visually impaired people. The author failed to provide the complete solution for the problems faced by this method. A complete review of the Smart Cane, Ultra Cane, I Cane, Guide Cane, and K-Sonar systems was fixed to a white cane and it can cover only single sensing direction.

Gandhi et al. (2015) Developed a Computer vision based system that uses Ultrasonic sensor and an Arduino. This system includes ultrasonic sensor and Arduino which is wearied in the knee of the impaired person for detecting the obstacles. Drawback of this is it is unable to detect properly when more object is present.

Ebenezer et al proposed a voice assisting system using GPS technology for visually impaired person. The system also gives intimation to the caretakers of the impaired person under critical conditions. In this method the voice and GSM communication is given through the IOT technologies. Even though the system brigs the innovative results it fails to give details about the type of obstacle and the distance between the obstacle and the disable person [15].

Sarpute etal presented a Arduino based smart cane assisting device for the visually impaired person. GPS technology is used to tell between the locations of the obstacle and also helps the disabled person in detecting the obstacles. The system uses Ultrasonic sensors for measuring the distance and it also includes the modules such as Bluetooth, GSM, GPS and RFID sensors. [16]

Dey et al proposed an ultrasonic sensor based walking rod for visually impaired person. By using this method the obstacle can be detected within a range of 5 to 35 cm distance. Three ultrasonic sensor is used for detecting the obstacle in forward, right and in left direction [17].

Bose et al developed a digital assistant device for visually impaired people which helps in accessing internet. Which helps the disable person to send and receive emails, access day to day news, weather forecasting, and also to set reminders and alarms.[18]

Maidenbaum, et al. (2014) developed the Eye Cane, a new blind technology, behavior and swift learning for the electronic travel aid. Old-style eye can was slightly modified with audio output. In this method the obstacle is able to detect in different heights [19].

Cosgun et al. (2014), proposed an guidance for human navigation using a vibro-tactile belt interface. A laser based person tracking system was proposed to assist human in navigation. An ellipse-fitting approach is used to find the position and orientation of humans [20]. This paper proposes a feedback based mechanical assistance device with sensor coupled wearable device. This method provide a solution for visually diminished people to circumnavigate in the environment easily. The sensor information coupled with voice assistance device give information about the obstacles in terms of distance and the object details. This provide a solution for safe navigation for the blind people. Wearable navigation technology along with an less weight sensors fixed with haptic devices in clothes plays a very important in the day today life of visually impaired people [8]. Here the raspberry pi is the centre part of the device. All the components are connected to the raspberry pi. The small credit card sized Raspberry pi computer is plugs into the computer and television. The processor is connected to any power supply like power bank, all the connections are given on the haptic strap [7] that will be worn by the users for easy detection and navigation. A study on [1] using ultrasonic sensor instead of that here Lidar is connected to the raspberry pi, LiDAR (light detection and ranging), is a remote sensing method used for measuring the distance between an object for high accuracy along with the vibrotactile motor and computer vision technology images are displayed in the monitor which can be seen anywhere and monitored the impaired user haptic strap[6] .

II. HARDWARE COMPONENTS

The Hardware components required in this device are Raspberry pi, LiDAR, Camera, Motor, Relay module, wearable strap, Headphone, USB cable, Power supply unit using all these components proposed system is designed. The hardware components used for the implementation is as fallows.

A The Raspberry Pi 3

Broadcom BCM2837 SOC with 1.2GHz 64-bit quad-core – A53, 512 kb shared L2 cache (64-bit instruction set ARMv8) is used as a processor. The processor reads the distance and gives as an audio signal to the audio jockey.

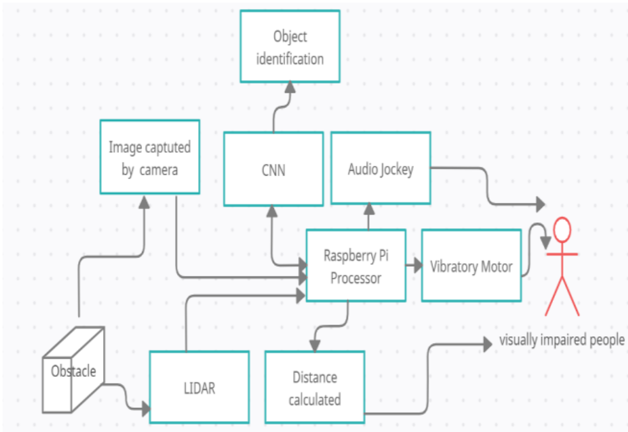

Fig.1 Block Diagram

Fig.2.LiDAR

B. LIDAR:

Light Detection and Ranging (LiDAR) is a remote sensing method used to examine the object [2]. A lidar is a laser range measurement device shown in Fig .2 The Lidar sends the pulse out, when the obstacle is detected the pulse hit backs to the LiDAR and distance of the object is calculated using Time of Flight (TOF) measurement.

C Vibratory motor

A dc motor is a rotatory electric motor that converts direct current electrical energy into mechanical energy [3]. The common types of rely on the forces produced by magnetic fields. At high level all types of DC motors have some internal mechanism in it, either electro mechanical or electronics, to periodically change the direction of current in part of the motor . When the obstacle is detected by the LiDAR sensor it starts displaying the distance of the obstacle, when the obstacle is very near the motor which is attached to the relay module starts to vibrate, so dc motor used here is known as the vibratory motor.

D. Camera:

A webcam is used in this proposed system for streaming the videos. The streamed images and videos in real time is fed to the computer through a to a computer network. continuous video stream goes on. For every ten second the camera captures the image and the image of the obstacle will be displayed along with its accuracy using image processing techniques, here the device is trained on fifteen objects [9], when the trained objects are displayed then the name of that obstacle will be displayed, the camera used is dimensioned so many obstacles can be detected at the same time by the webcam.

E. Haptic strap:

The haptic strap [7] looks like a belt it holds all the hardware components like sensors, processor, vibratory motors , camera ,relay module etc, it acts as holder and it is the one of important component in the system. Image processing [4] is the process of manipulating pixel data in order to make it comfortable for computer vision applications and to make it suitable to present it to humans. Along with the help of neural networks image processing can be done.

F. Audio Jockey:

When the camera captures the image of the obstacle, the name of the obstacle detected is informed to the blind people through the audio Jockey .So that they can avoid the obstacle when they are in motion.

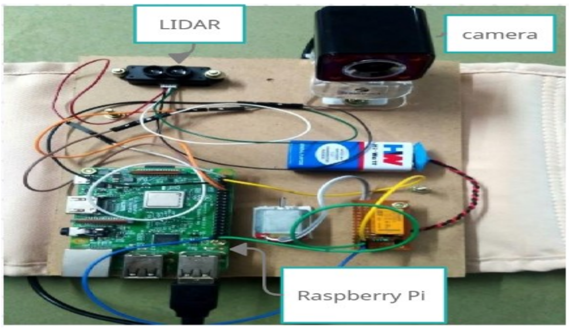

Fig. 3 Hapatic strap components used in the proposed system

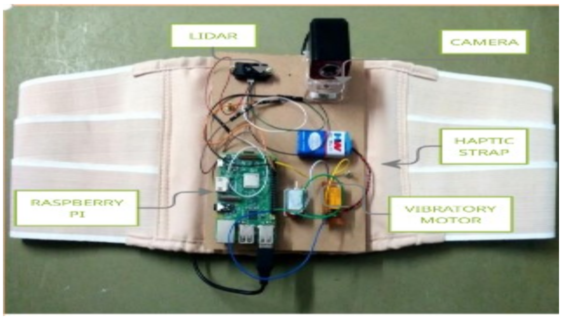

Fig. 4 complete view of Proposed system

III. WORKING PRINCIPLE

When the visually impaired people moves near the obstacle. The camera which is fixed in front of the hepatic strap capture the image of the object. The captured image is processed by image processing software and the description of the object is given as voice message to the user by means of audio output.

The proposed method uses images captured by the camera combined with machine learning techniques to determine the objects in front of them. B using the LiDAR sensor the distance between the object is calculated and it is also given as one of the input to the impaired person. If the obstacle is very close to the person vibratory motor fixed in the hepatic strap vibrates to alert the user. Now the people founds the object is there. Long distance object is identified and tells through the headphone. In short distance the motor start to vibrate. LiDAR data is processed by the Raspberry pi processor and the measured distance is displayed in the display unit which is also given as command to the impaired person.

LiDAR follows a simple principle that it allows the laser light to fall on the object of interest and calculate the time it takes to return to the LiDAR source. The formula used to find the distance: The distance of the object = (Speed of Light x Time of Flight) / 2.

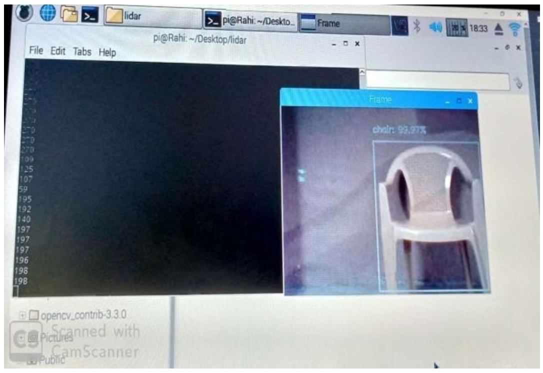

Fig. 5 Picture captured by camera with name of the object as chair and its accuracy

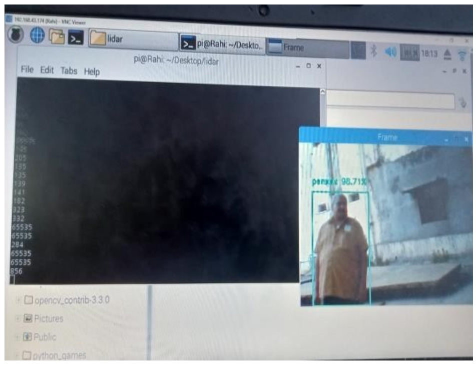

Fig.6 Picture captured by camera with name of the object as person and its accuracy

The convolution neural network is trained with 20

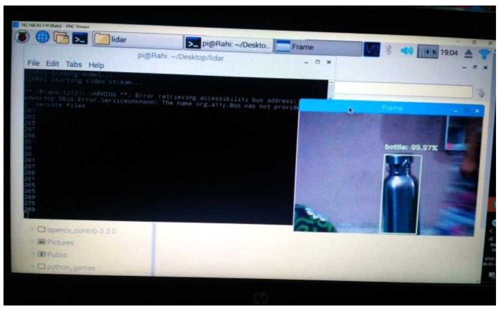

Fig. 7 Picture captured by camera with name of the object as bottle and its accuracy

different objects such as bicycle, bus, car, cat, chair, cow, dining table, dog, horse, motorbike, person, plant, Sheep, sofa, train, TV monitor, water bottle, bucket, bird and heavy vehicle. Real time images such as chair, person, bottle, and bicycle is considered as test data and the result obtained is shown in the figure 5 to figure 8. The image processing and classification program is implemented in PYTHON.

IV. RESULT AND DISCUSSION

When an impaired person is near to the obstacle the image of the obstacle is captured by the camera and classified using convolution neural network. The identified object is given as an audio output to the user. The distance is measured using LIDAR sensor and the distance is also given as one more input to the user. If the object is very closer alert is also given by using the vibratory motor. The connections are made for haptic strap is shown in Figure 3. The Raspberry pi processor board, Vibratory motor, LiDAR, Relay module, Camera and USB are attached in the belt. Using GPIO pins in Raspberry pi the LiDAR and Relay module are connected. Vibratory motor and Battery is connected to the Relay module and Camera is directly connected to the HDMI port of processor which is shown in Figure 4. The time divided by the speed of light or sound gives you the distance the signal traveled out and back. Divide that by two to get the distance to the object. The obstacle consider for experimental analysis is person, Bicycle, Bottle and Chair. When there is a chair on the path chair is considered as the obstacle, the camera captures the image of chair. From the image obtain the descriptive of the obstacle is given as an audio input to the visually impaired people. The obstacle distance also given as an input to the visually impaired people, so that they can be alerted before few distance. In this method limited number of obstacle was tested. In future more number of obstacle image is ca be captured and trained using machine learning algorithms

The person to be considered as obstacle and its corresponding output is shown in Figure 6. Figure 7 shows the output image of a bottle which is considered as an obstacle. When a bicycle comes in the path which is intimated to the visually impaired person which is shown in figure 8. once the object is identified then the camera captures the picture of the object. Then using head phone name of the object is communicated to the visually impaired person. LiDAR measures the distance of the object. If the people moves near to the obstacle the motor vibrate. Now the people founds the object is there. Long distance object is identified and tells through the headphone. In short distance the motor start to vibrate.

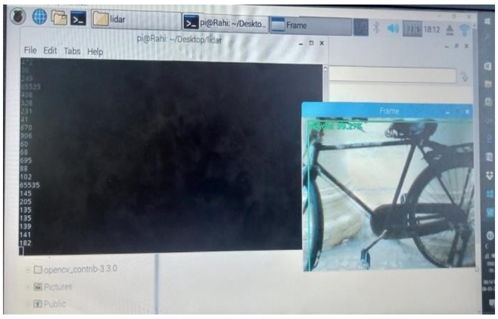

Fig.8 Picture captured by camera with name of the object as bicycle and its accuracy.

V. CONCLUSION AND FUTURE WORK

In this paper, a wireless LIDAR based voice assistance device is proposed for detection of obstacles in front of the visually impaired people. The experiments was conducted with few objects such as chair, bicycle, person and a water bottle. The proposed method is able to detect the obstacles very effectively. From the experimental result, the proposed system only few obstacles images has been trained to recognize the effectiveness in the detection of obstacle can be confirmed. This work can be extended with more number of moving objects under different conditions. In future network should be trained with more objects to have better identification of obstacles which is one of the limitation of the work.

The work can extend in future with GPS tracking system. The number of sensor and the position of the sensor can be increased to have the effect full detection of obstacles in front and behind the visually impaired people.

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