An Obstacle Detection And Distance Sensing Algorithm For Visually Impaired Persons

T.Suba Nachiar, Dr.M.Arunachalam, P.R.Hemalatha, Dr.R.Aghila, R.T.Subhalakshmi

Abstract : Object detection and distance sensing is a major challenge for visually impaired persons. Earlier navigation systems are expensive and time consuming for usage in day-to-day life. Our proposed system uses Ultrasonic sensors which work on the principle of reflected sound waves. Whenever any obstacle is detected in ultrasonic sensor interfaced in the Specs of a person, camera capture the image. The image captured is compared with the images against a convolution neural network, which will be used to find the obstacles. This work aims at designing a cost-effective and more flexible navigation system for the visually impaired persons.

Index terms : Obstacle detection, distance sensing, ultrasonic sensor, distance calculation, speech output

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I. INTRODUCTION

With 39 million blind people globally, our country has one-third (i.e., 12 million blind people) of the world's blind population. Sensing the distance for obstacles and navigating to destination beyond the distance are the major problems for the visually impaired persons in their day-to-day life. Visually impaired persons depends on support of humans, pet animals and canes for navigation. The walking cane is a portable mechanical device to detect static obstacles only within a specified range. The device range is very limited and it is not flexible for protection from obstacles near to head area. Another travel aid for the blind is with the guide of pets. The pet animals are not able to detect and analyse the complex situations and their average life time is only 7 years (on average). In such environment, navigational systems are expensive and time consuming for the visually impaired persons and trouble for others too. Our work suggested an efficient navigation system for visually impaired persons. The prototype is designed with one camera placed on blind person's specs for obstacle detection and distance sensing.This paper is organized as follows: Section II describes the related study, Section III describes the proposed system. Result and discussion is presented in Section IV and Conclusion in Section V.

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II. RELATED STUDY

Data-on-demand is essential nowadays to step out to the next era ie.,Internet of things. Gubbi et al (2013) discussed a Cloud centric vision for worldwide implementation of Internet of Things. In this paper, they have presented a Cloud implementation using Aneka, which was based on interaction of private and public Clouds. Data sources need to be connected and related to each other to cope with the heterogeneity of available technologies. To achieve this task, a flexible and dynamic middleware support is essential which provides zero-programming deployment. In this paper , Aberer et al (2006) presented an overview on Global Sensor Networks (GSN) middleware which supports and offers a flexible, zero-programming deployment and integration infrastructure. GSN's enables the user to declaratively specify XML-based deployment descriptors in combination with the possibility to integrate sensor network data through plain SQL queries over local and remote sensor data sources. Manikanta et al (2018) proposed an algorithm which uses ultrasonic sensors to detect obstacles ahead using ultrasonic waves. The

significant feature of this algorithm is that it allows the blind to detect if there is light or darkness in the room. The proposed system has a wireless RF based remote which helps the blind person to find their stick. Daniyal Rajput et al (2014) developed a Smart obstacle detector system to help blind people to perform their work easily and comfortably. A normal cane/stick detection system was not much efficient and difficult for blind person to move . The proposed system detects the object by video processing method with the help of camera. This system used video processing for efficient and fast detection of objects. When objects come in range of ultrasonic sensor, then handle of the stick increases vibration if the object comes toward the stick and vibration decreases when object goes far from the stick. To increase the independent mobility of visually impaired persons, Strothotte et al (2013) developed a new travel aid MoBIC Outdoor System (MoODS). This travel aid consists of two interrelated components: the MoBIC Pre-Journey System (MoPS) to assist users in planning journeys, and the MoBIC Outdoor System (MoODS) is a secondary aid, complementing primary aids such as the long cane or guide dog by providing users with orientation and navigation assistance during journeys. Based on the detailed investigation on augmented realitiy technologies, Thomas et al (1998) developed visual navigation aids to users. This navigation aid is designed with wearable computer system with a see-through display, digital compass, and a differential GPS to provide visual cues. Al-Shehabi et al (2014) developed a wearable navigation aid for visually impaired persons to reach their desirable desination in an unfamiliar environment. This aid comprises of Kinect unit, a Tablet PC, a microcontroller, IMU sensors, and vibration actuators for orienting the user towards the next direction of movement.

III. PROPOSED SYSTEM

The proposed system is specially designed to guide the blind people by providing information about appropriate or obstacle free path. The logical structure of our system is shown in Figure 1. This can be divided into three main parts: the user control, sensor control, and the output to the user.

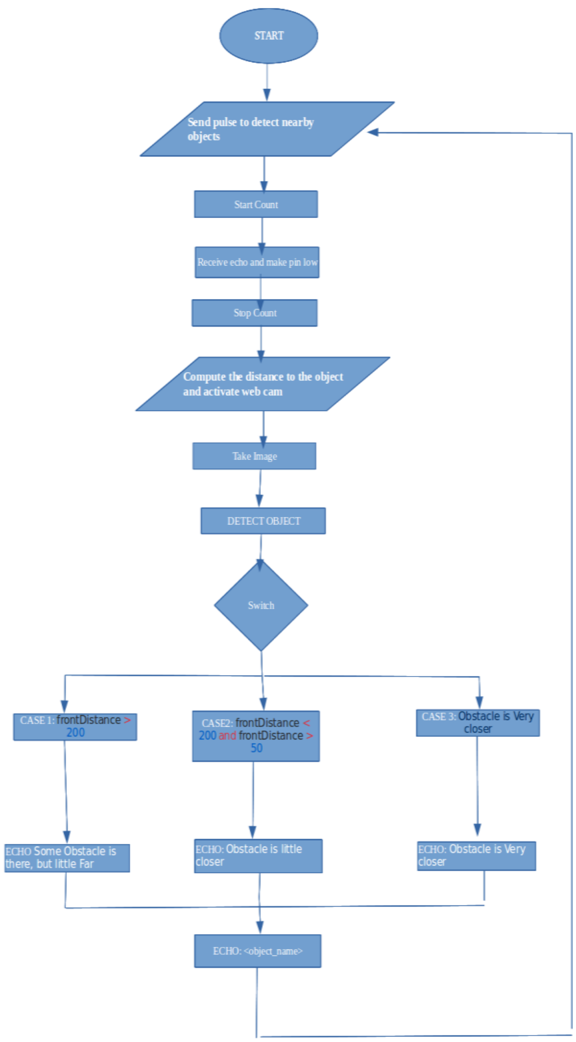

Fig 1:*Logical Structure of Proposed System*

An ultrasonic sensor is the main component used for obstacle detection, which is shown in Figure 2. It consists of a transmitter and a receiver in cylindrical structure placed parallel to one another. The ultrasonic sensor will scan the complete area in the range of the ultrasonic beam. Any obstacle that lies in the scanning range of the beam will be reflected and picked back by the receiver unit in the sensor. The distance determination depends on the body that has caused the beam reflection. The microcontroller controls the sending and reception of the signals to the other components. The mp3 module plays the required distance clip into the headphones. It uses an SD card as memory for storing the recorded clips. It uses ultrasonic sensors, a memory chip, a microcontroller and headphones. The prototype is designed to sense an obstacle within 1.8m.

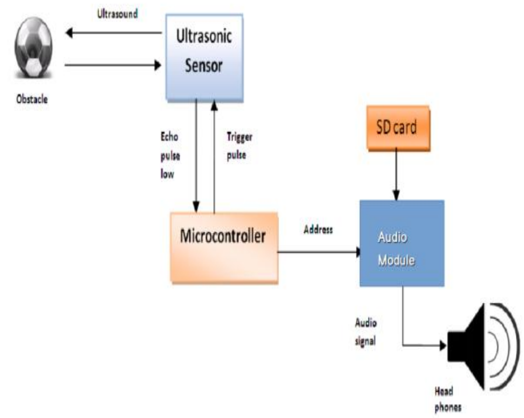

Fig 2: *Distance detection using Ultrasonic sensor*

The Proposed system comprises of three phases as presented below:
A.Distance Calculation
B.Text to Speech
C.Speech output

A .Distance Calculation

Step 1: When the ultrasonic is triggered by a pulse, it is sent to the trigger pin (min. 10 millisecond pulse width), which inturn sends a burst of 8 ultrasonic waves through the transmitter. Pulse time of the transmitted ultrasonic wave is calculated thereby.
Step 2:The ultrasonic waves reflected from an obstacle are picked by the receiver and the echo pin goes low.

Step 3:The distance is calculated using the formula:
Distance = Time (for which the echo pin was high) * Speed of ultrasonic wave in air.

Step 4:Finally, the distance of the object is returned to another function to enable audio transmission to the user to indicated him of the obstacle which is close to him.

Step 5:The distance measured will trigger the webcam to take a snapshot and send it to an image recognition API , which have a trained data model that detects the image / object in the image.

B .Text to Speech module

The subprocess module in Python language allows you to spawn new processes, connect to their input/output/error pipes, and obtain their return codes. The coding statement below is responsible for converting the found text to audio: subprocess.call(["sudo","espeak",data]) When headphones connected directly to the Raspberry Pi, it may find the volume a little lacking. The amplifier inside will help boost the signal to a more audible level. The application will give voice message to the blind person and it will help the person for identifying the path . The object gets detected by the key matching technique which is used in the algorithm (Figure 3). It matches the object with the neural network model to confirm the obstacle that comes into the way. When object is matched with model the application gives the voice instruction by using the Speech synthesizer.

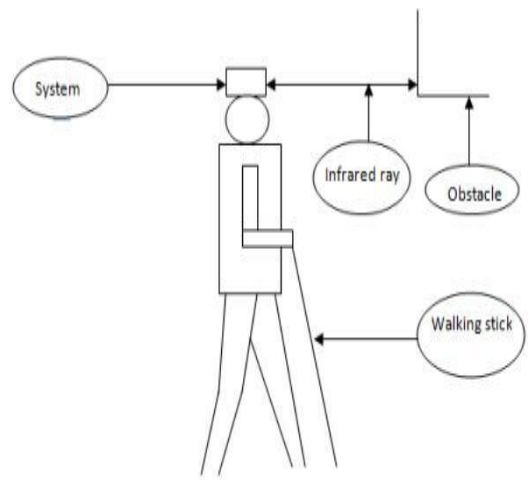

Fig 3: *Object Detection*

C. Speech Output

This module alerts the user about the object in front of them and convey the information to the users (especially when crossing roads). If motion is detected, the object is recognized and it is converted into TTS to alert the users. Blind users can take necessary precautions or stop for a while till the motion in front of them stop

IV. RESULT AND DISCUSSION

In this system, Raspberry Pi model with 512 MB RAM along with 2 USB ports is used for implemetation. It also provides the option of Ethernet networking and storage is provided using an SD card. The Broadcom BCM2835 System on a Chip (SOC) is at the heart of the Pi. The common hardware components of a PC have been fabricated into a small chip. The CPU is ARM1176JZF-S which runs at 700 MHz and belongs to the ARM11 family. For graphics, Broadcom Video Core IV GPU is used in the Raspberry Pi, which is quite powerful for such a small device and capable of full HD video playback.

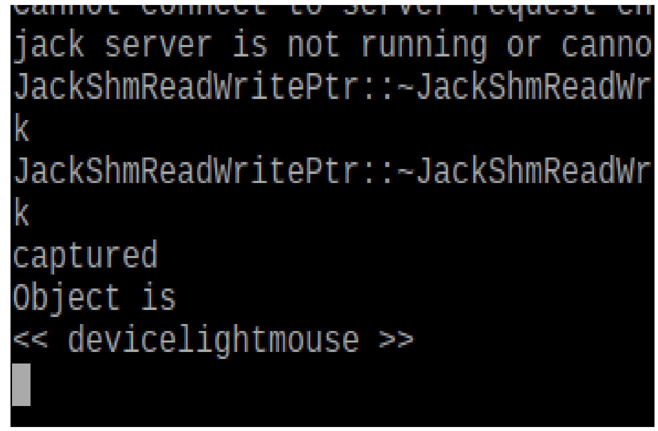

Fig 4: *Output Screenshot*

The testing snapshot in Figure 4 extensively shows the distance of the person from the obstruction. There are four obstruction namely: wood, paper, cloth, plastic and metal, different colors were used to represent them in the chart. The initial distance of the person from the obstruction is about 80cm. As the time increases, the distance measured is supposed to decrease because the person is getting closer to the obstacle. Four of the obstructions namely: wood, paper, glass and metal display a common pattern. The measured distance is erroneous for the rippled cloth, the sound waves was not reflected efficiently, in return the audio conversion failed to execute the condition designed in the program. However, based on our observation, when the cloth is perfectly flattened, the person was able to follow the specified program. Finally, a consistency is observed in the distance measured after four seconds and onwards over the obstructions. The testing result shows a positive correlation coefficient among the wood, paper, plastic and metal. It clearly proves that ultrasonic sensor used in this experiment resulted to the same pattern of distance measurement and obtained approximately the same measured value. This result is with exemption to the rippled cloth which resulted in an almost low negative correlation when compared to the above mentioned materials. Furthermore, it can be observed that classification was not good as indicated by the higher value of Cross Entropy on training, validation and testing. Therefore, the method of distance measurement for the classification of the types of obstruction using ultrasonic sensor executed considerable results. In this study, the data were acquired using ultrasonic sensor, different types of materials and software programming. The analysis and interpretation of the data were carried out using Multiple Correlation and Neural Network. The person was to move slowly as it approached near the obstruction, and stopped when reached the distance of 15 cm.

V. CONCLUSION AND FUTURE SCOPE

It is a simple, economical, configurable electronic guidance system which is easy to handle and it is proposed to provide constructive assistant and support for blind and visually impaired persons. The results show that the system is efficient and unique in detecting the distance and identifying the object that the blind person may encounter. For this proposed system, special training is not required. It also resolves limitations of other systems that are related to mobility oriented problems that influences the blind people in their environment. Future work on this system will be focused to enhance the performance of the system and reducing the load on the user and to incorporate additional features thereby making it a more efficient device. With the addition of face recognition feature, the device can be modeled to store the facial details of people closely related to the user which will help him or her differentiate between peers and strangers.The device can be modified to identify numbers, colors and shapes which will be of more use to the user even in the outdoor environment.

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