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Image Processing and Bone Conduction for Deaf and Blind People

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Abstract:- When hearing and sight fail, the human need for communication continues to remain intact. Deaf-blindness is a unique disability that combines varying degrees of both hearing and visual impairment. Individuals who are deaf-blind experience extreme challenges with communication and mobility. Over time and with the advancement in technology, a variety of communication technologies are available for deaf-blind individuals. Despite the available communication technology for deaf- blind individuals and the advancement in the field of Image Processing, we still lack a system/device to help deaf-blind individuals go independently. With the help of Image Processing, bone conduction and the education provided to them we can develop a warning system that provides environmental awareness to deaf-blind people, thus helping them participate in social norms independently.

This paper provides the methodology to design and implement a device for the deaf-blind people. Finally, some potential topics and challenges for future research are highlighted.

Keywords:- *Bone Conduction, Haar cascade, OpenCV, TensorFlow.*

I. INTRODUCTION

As we all are aware, there is a myth that people with some imparity should be assisted by someone. But here we are trying to make such impaired people independent. This article focuses on designing and implementing a device specially for deaf-blind people [7].The main aim of this project is to develop a device to provide an effective visual platform to enhance the perception of the surroundings, for a visual and hearing impaired user.

This work offers an excellent solution for the people with low vision and disabled hearing [8]. This work serves as a simple yet efficient method for providing a glimpse of the world through audio as per the situation under test. It is developed by using the concept of image processing segmentation, feature extraction, along with database which consists of pre-fed data that aids in the recognition of the image captured.

Image processing can be implemented in many ways like MatLAB, OpenCV and others. The best suited method is OpenCV [2]. We also use the machine learning software TensorFlow(Figure 1).

Bone conduction is the conduction to the inner ear through the bones of the skull (Figure 2). Bone conduction transmission can be used on individuals with normal or impaired hearing. This technique is used to convey the information captured by the image to the user in the form of mechanical vibrations to the user through the cranial/temple bone. Using this concept, we can build a bone conducting headphone [5]. Not only for deaf-blind, but people who are only blind also can use this device as it increases the situational awareness. With bone conduction headphones, here are no speakers going over or into ears, thereby depleting their audio senses. Instead, the transducerssit on cheek bones directly in front of ears, leaving ears completely open to surroundings [8].

With the help of Raspberry pi, a user-friendly device is designed with minimal wirework and mounting accessories. This device can be used as a warning system for those who are visionless/unsighted with impaired hearing.

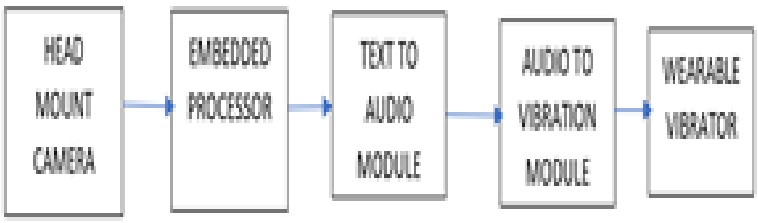

Fig. 1: Block diagram

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Fig. 2: Working of Bone Conduction

II. METHODOLOGY

The detailed block diagram for implementation is as shown in Figure 3. Here Head mount camera captures the surroundings and the image is converted into gray. The content of each frame is read and the features of this image are mapped with the features of pre trained cascade classifier to detect the object. Once the object is detected it is converted into audio using pyttsx module. This audio output is given to the bone conduction headphones. On the other hand, two ultrasonic sensors are used which alerts the user about the presence of object to his left or right. From the output of the ultrasonic sensor, the distance of the object is calculated and is compared with the threshold distance. If the distance is less than the threshold, a signal is sent to the vibrator that alerts the user.

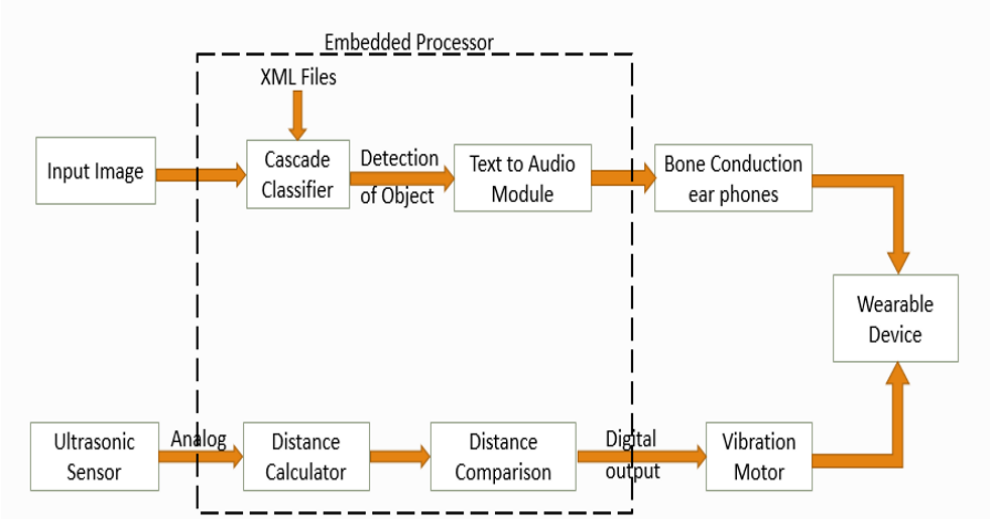

Fig. 3: Overall Block Diagram

Ultrasonic sensors are used to detect obstacle within a threshold range of 4m. If the obstacle is detected within the threshold given, then it sends the signal to raspberry pi and in turn intimidate the camera to capture the image. Since the resolution of the captured image is very high, the computations are more. To reduce the computation, foreground extraction of an image should be done. Once the foreground extraction is done, next step is object detection.

Haar cascading is used for object detection. Object detection using Haar feature based cascade classifiers is a machine learning based approach where cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images. In this project, different objects are trained and Haar cascade algorithm is applied for object detection [11]. The algorithm for Haar Cascade is as shown in Figure 4.

Once the object detection is done, it is converted into audio. This audio is given as input to the bone conduction headphone (Figure. 3). It is made using normal earphones. The speakers of normal earphones are cut off and a piezo-electric buzzer is soldered to it. When it is used, the headphone enables the user to hear the audio output and also a person only with visual impairment gives full awareness of surroundings as well [5].

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```
•Import xml file
object_cascade=cv2.CascadeClassifier(óbject_file.xml')
•Video Acquisition
        Cap=cv2.VideoCapture(0) While 1:
                ret, img= cap.read()

•Detect Object
Object= object_cascade.detectMultiScale(img)

•Draw rectangle around object
Cv2.rectanglr(img,  y),  (x+w,  y+h), (0,0,255),2)

•Display
•Cv2.imshow(ímage', img)
```

Fig. 4: Haar Cascade Algorithm

Haar cascading is a method used for object detection. Here the cascade function is trained from the lot of positive and negative images which is then used to detect objects in other images [11]. In OpenCV, this is done using Cascade-Classifier function. This takes the XML files as input. XML files are generated using large number of positive negative images of particular object of interest. For many objects, we need create separate XML files [2].

Generating XML files includes the following major steps.

- Collecting negative or background images
- Collecting or creating positive images
- Creating a positive vector file by stitching together all positives
- Training cascade

These XML files are then used for the object detection.

III. RESULTS

The device developed is capable of capturing the images present around the user with the help head-mount camera present on the device. The object present in the image is then detected by the trained cascade classifier. The field of view of the camera used is 60 degree. To improve the range of field of view, ultrasonic sensors is used to detect ny object within the range of 4m from the user , along with that vibrators are installed on both the shoulders of the user. Whenever obstacle is present on either side, the vibrator vibrates. Then the user can turn his head towards the obstacle and the camera captures the image and the object present is detected. The Raspberry PI camera module captures an image of this object. With the help of XML files and Haar Cascade classifier function, the object in the image is detected and a text output is made available. This text is then converted into it's audio form with the help of a Text to Audio API which is then given as an input to the Bone Conduction earphones constructed using a Piezoelectric buzzer. The user gets to know what the object is, by the bone conduction mechanism.

The output of trained cascade classifier for detecting cat, face, human body and car are shown in Figure 5, Figure 6 and Figure 7 respectively. The bone conduction and wearable device is as shown in Figure 8 and Figure 9.

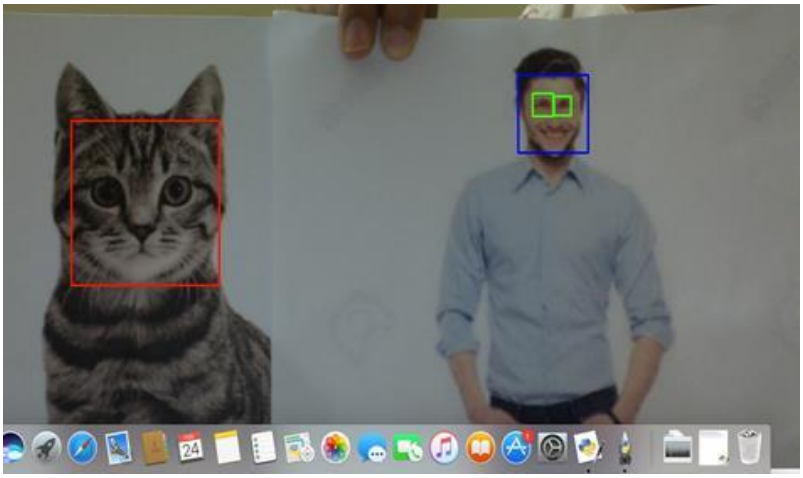

Fig. 5: Cat and Human face detected by the trained classifier

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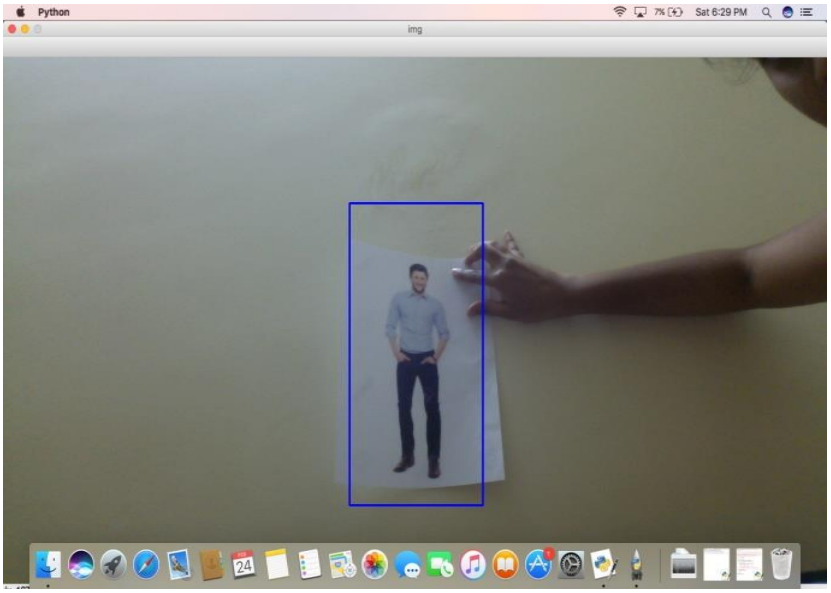

Fig. 6: Human body detected by the trained classifier

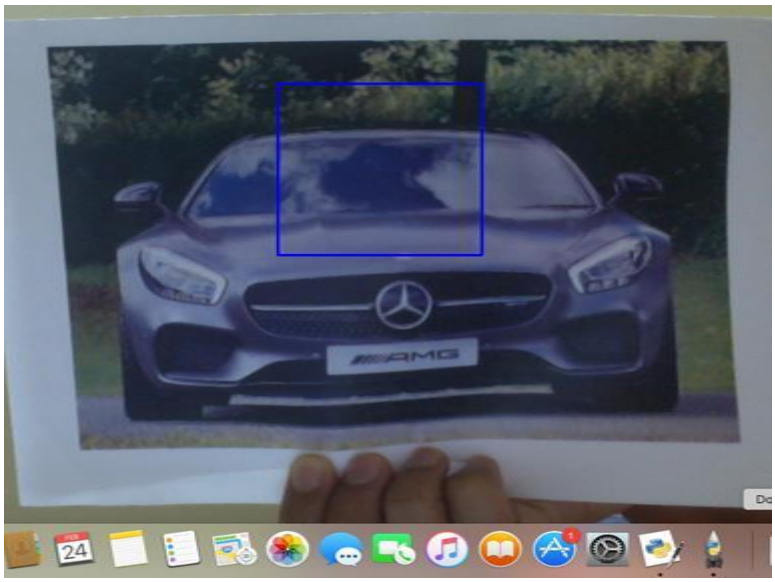

Fig. 7: Car detected by the trained classifier

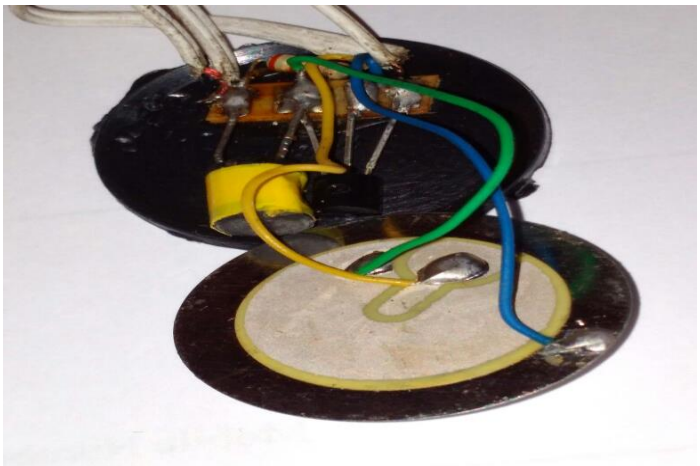

Fig. 8: Bone Conduction Headphones constructed using piezo electric buzzer

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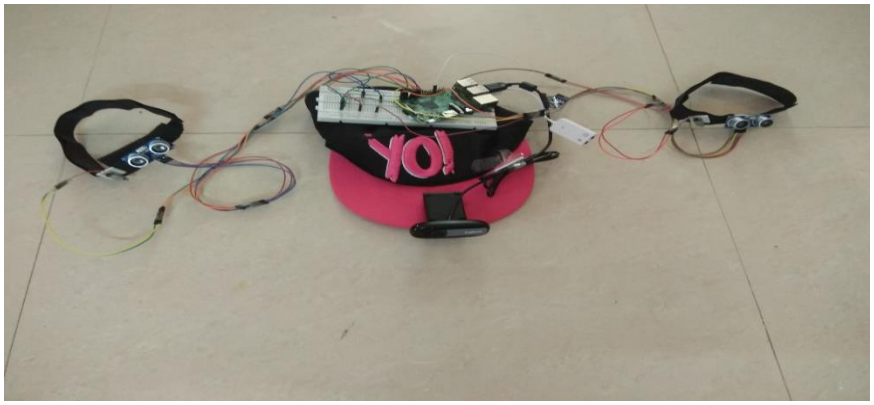

Fig. 9: Wearable Device

IV. FUTURE SCOPE

In addition, TensorFlow can be used which helps detection of objects with increased accuracy [13].TensorFlow is used for deep learning purposes and is an open source machine learning platform. It contains a wide range of functionalities and is mainly designed for deep neural network models. The neural network could be effectively used in designing the reconstruction filter of bone-conducted speech for better quality by utilizing an MLP filter(a class of feedforward artificial neural network).

Artificial intelligence can be used to better analyze fed data from cameras and sensors. Using artificial intelligence in conjunction with wearable technologies is leading toward innovation in accessibility for everyone.

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