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COVID-19 Safe Distance Alert System for Blind People

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A***bstract:*** *Real time object detection and distance measurement for blind people to maintain social distancing. Real time object detections and calculating distances is a challenging task for many computer vision applications such as video surveillance, robot navigation and vehicle navigation. Object detection involves detecting the object in sequence of videos using OpenCV under python. Every distance calculation mechanism requires object detection mechanism for each frame or when an object appears newly on the video sequence. Object distance is process of calculating distance of one object or multiple objects from the camera using single vision camera.*

Key Word: *Object detection distance measurement; OpenCV Camera.*

I. Introduction

Object detection is critical and may have some disadvantages. Hence, there is scope of improvement on the research. The research we have done here using Image Processing and Machine Learning which helps to improve all existing research and provides faster and accurate result for a blind person Everybody deserves to live independently, especially those who are disabled, in the last few years, technology gives attention to disabled people to hem control their life easily as possible. In recent, COVID-19 pandemic has a significant impact on our daily lives particularly on blind people. So,it is very important to maintain social distancing but for blind people it is very difficult to follow the guideline. Therefore, work is proposed to help the blind people whose main objective is to identify the object and alert the person and to develop a module which will act as a virtual eye for blind people. The obtained results indicated the success of the proposed model in giving blind users the capability to move around in unfamiliar indoor-outdoor environment and giving them the safety of their lives in today's COVID19 pandemic, through a user-friendly device by person and object identification model.

II. Literature review

In the past lots of research have been done to find the distance of an object from camera. But, in most of the cases single vision camera is used to find the distance. According to (Yasir M Mustafah) [1], Stereo camera can be used to find the distance between object and camera which is done by two cameras connected in parallel to each other in certain position the distance of particular object can be measured when it enters the same area of the both cameras [1]. In the given method it is proposed that the system depends strictly on constant environment due to background reduction for object detection. Which may be improved by applying additional background reduction method. And

the precision of the mensuration is relies on the resolution of the camera. More the resolution of camera more will be the precision. [2]. In the system below the distance between object and camera is find by using TensorFlow API model and eye tracking system in real time also the model Mobile net SSD is used to replace the network with the basic network structure. The network is a light-weight, low latency and economically efficient embedded vision model. [3] In the system given, object measurement is done by using camera only which is cost effective system and has the accurate solution. The camera parameters are divided into two parts first as intrinsic camera parameter which includes Vertical Field of View (VFOW)and Horizontal Field of View (HFOW) and second as extrinsic camera parameter which includes Segmentation, Classification and parameter extraction. [4] In this the measurement of distance is done by using Non-Metric Camera instead of using digital camera. In nonmetric camera the internal orientation elements are not known such as focal length, coordinates of points and lens distortion. It focuses more on quality of image rather than quality of geometry of image. [5]. Different types of cameras are used with average resolution without zooming which may affect the result.

The object are often known by complete frame of the camera. The upper edge and lower edge can be detected and processed on basis of count of pixels. Take the snapshot, find the coordinates of the object count the pixel from horizontal and vertical direction and measure the distance of object. [6].The real time distance of an object is found by using modified camera in which the relative abundances of any glass and effects of dust are wash out by strong red Halpha emission. [7]. Detection of eyes, faces and iris is done to measure the distance between face and the camera. By using triangle similarity theorem distance is calculated and image processing by using OpenCV. Haar like classifier with Adaboost is used for human face detection and Hugo transform the circular iris but it only calculates the distance up to 40 cm only When is distance is more than 40 cm the linearity relation cannot be maintained and error in final result gets affected. [8]. Capture the image and use the information received from the frequency domain analysis of an image.

Combine the frequency domain information with time domain which helps to find the accurate disparity maps which leads to the accurate distance measurement of the object from stereo camera. It calculates the frequency values included in the images and disparity can be calculated directly from the phase value, we have the option to capture an image as well as capture a video in real time. [9]. Cognex camera is used to measure distance because it has a high quality and friendly software. It is a multi-focus camera which capture 3 images simultaneously with different focus values. we can reduce errors by converting pixel from camera frame to millimetre and get the accuracy [10]. The above study shows the gap in existing method of object detection so, we are providing new method to blind person distance alert.

Considering above review, the CNN based object detection is useful for masked person detection. The methodology below explains about object detection and inference modules implemented for alert mechanism.

III. Methodology

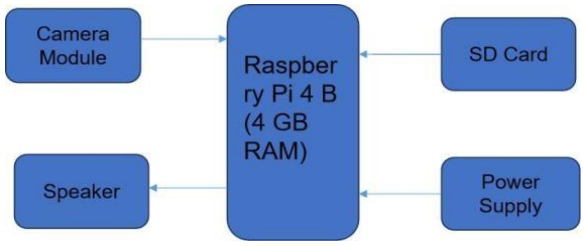
The system consists of embedded module, camera module is attached to the CSI ports available on Raspberry Pi Module 4 B microcomputer. It will capture the real-time video feed from the camera module and further send it to the processor which will perform the scaling, filtering, background subtraction, thresholding, morphological and blob extraction operations on it to detect the objects appearing in the feed. Distance is calculated from the camera module using triangle similarity algorithm and if any object is in particular range i.e. 30 cm then alert is generated which is in the audio format.

Block diagram:

The figure 1 shows the implementation details in blocks. The Raspberry Pi module is used for inference purpose. The actual training is happening on standalone Desktop PC with GPU. The USB camera is connected to RPi module for

detecting the images and videos in real-time. The RaspberryPi is not capable to handle the Tensorflow hence its recommended to use Tensorflow-lite using OpenCV for image processing.

Figure No 1: System Block Diagram

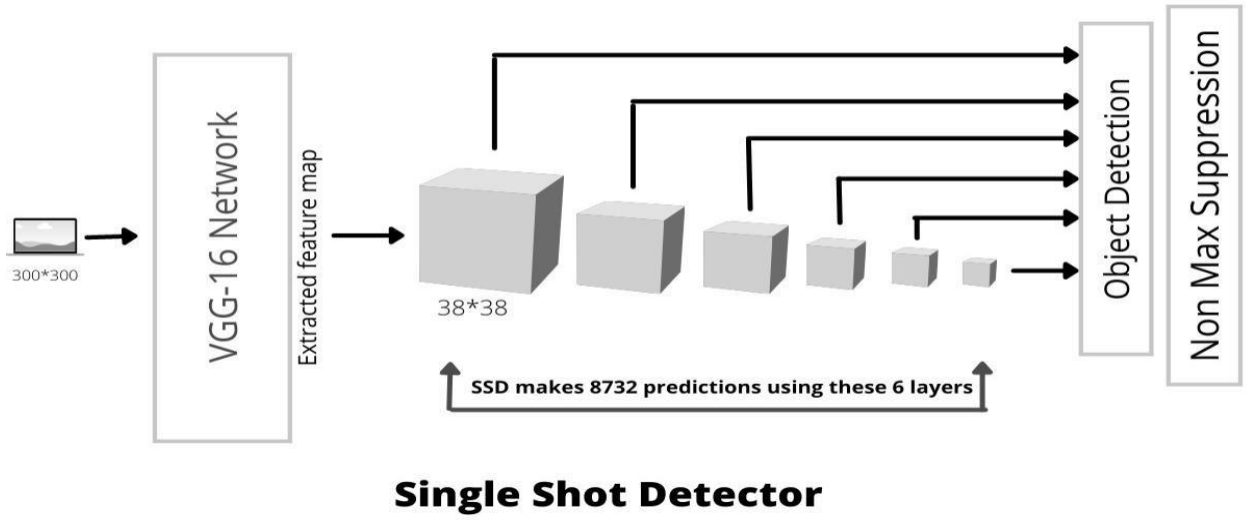


Raspberry pi 4B model of 4GB variant is connected with power supply of 5V, 3A adaptor. Camera module is connected to CSI port of raspberry pi 4B model which capture the video feed data and send to model. The data of video feed is stored in micro-SD card which is inserted in raspberry pi model. And speaker is connected to module for an audio output.

Object detection:

MobileNet is a computer vision model for TensorFlow. It is a convolutional neural network library. To detect the object provided to it by SSD (Single Shot Multi Box Detector) as shown in figure 2. It creates a rectangular box around the specified object and detects it by giving it a specified name from its library. TensorFlow is a deep neural network library developed by Google. To classify the objects and detect them using trained models in it. Trained this machine to detect and identify certain household objects such as water bottle, smartphone, fan, person, TV remote, etc. COCO dataset is used to train it. A COCO dataset is a popular object detection database which is used to train the machine learning applications. It contains over 80 categories from our day-to-day life.

Figure No 2: Architecture diagram of mobile Net SSD



SSD is used for object detection, In the above diagram input image is given to the VGG-16 network which extracts the feature map. The six convolutional layers perform the classification object detection task. At the object detection SSD makes 8732 predictions for each object that means for every object SSD predicts 8732 bounding boxes. Therefore, non max suppression is used to remove duplicate prediction. Hence the SSD will check confidence score of each and chooses the top 200 boxes per object.

Distance Finding:

This project is used to find the distance from the known object to camera. To complete this task, we are utilizing the triangle similarity method.

The triangle similarity for camera to object distance is defined as the ratio of width of object and focal length of camera to perceived width of object in pixels explained by equation no 1.

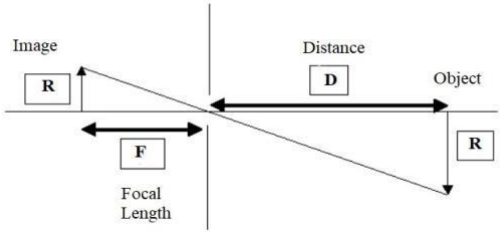
D = (W x F)/P - ……..(1)

Where, W= width of object

F= focal length of camera

P=perceived width of object in pixels

Figure No 3: Triangle Similarity Diagram

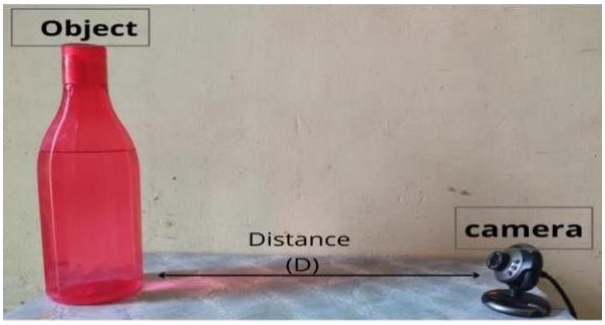


To accomplish triangle similarity method goes like this:

let us assume that the object is place at some distance D from camera. We have the known width W of object placed in front of camera. Then perceived with in pixels P is automatically determined by computer vision and image processing algorithm by capturing the object by camera given by equation 2. Thus, this gives us the perceived focal length of the camera.

. F = (P x D)/W …… (2)

Figure No 4: Actual distance of object from camera.



The figure 4 shows the real-time setup on distance calculation method. After determining the focal length, I can determine the distance of object to camera. If we change the distance of camera from object, the object width will also change. And through automatic image processing the perceived width of object in pixels is also changes. Thus, we get distance of object to camera. The figure 5 shows the calculated distance in "cm" unit of detected object.

Figure No 5: Calculated distance from camera to object

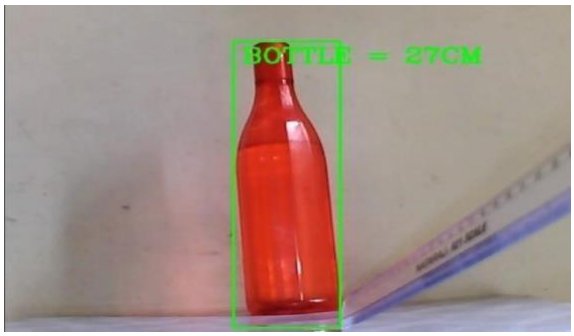


Figure 5: Calculated distance from camera to object

Text-to-speech:

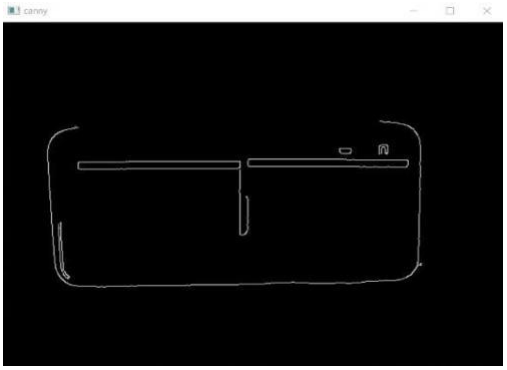
In order to convert text to speech format we need pyttsx3 which is python library. We have installed pyttsx3 python library using command: **pip install pyttsx3**

IV. Result

Thus, in our project we have successfully detected & identified the real time object and successfully achieved calculating the distance from camera to object.

Following are some implemented results and output images: With the help of OpenCV libraries first we have converted the image into grayscale image then by using gaussian blur filter Gray image is converted into blur image which will reduce noise from image, further edge detection shown in figure 6 is achieved by canny edge detection method.

Figure No 6: Edge Detection



Object Identification is done using Mobilenet SSD which is trained with coco-dataset. An sample of detected image is shown by figure 7.

Figure No 7: Object Identification

Distance measurement from camera to object is calculated by using triangle similarity method. The algorithm is explained by eq. 1 and 2 respectively. The figure 8 shows sample image with distance calculated between object and camera pointed towards the object.

Figure No 8: Distance Measurement

V. Discussion

In our discussion we have studied about many other models like Mobilenet SSD, yolo v3 for object detection, we conclude that Mobilenet SSD is faster in speed, but it has low accuracy. Thus, due to this faster speed or high FPS our object detection results are more fast and quick. And for distance calculation triangle similarity method is more effective than other method because this method gives us less errorless results of distance measurement. Table 1 shows the comparative observation between different State-of-the-Art models. Where, the Yolo dominates in object

detection on Desktop PC. But its difficult to deploy YOLO on Raspberry-pi. Hence MobilenetSSD and Faster R-CNN in lite module can be deployed on Raspberry Pi with FPS upto 7. Still its not much enough, but still there are possibilities to improve the FPS rate by changing the conversion rate from FP64 to INT8.

Table No 1: Comparative table

Models	Accuracy(in%)	Speed (in FPS)
Faster R-CNN	70	7
Mobilenet SSD	72.1	59
YOLO	80.3	45

VI. Conclusion

A distance measurement is aimed by using a single vision camera module which utilizes a simpler similarity of triangles algorithm that is more efficient, faster speed can be achieved. Therefore, this method will successfully alert the blind user and act as a virtual eye for them. The faster RCNN gives better accuracy up to 82% but with slow speed. The distance calculation can be improved by using dual camera mechanism, to avoid the issue of still frame background. Yet achieving the FPS rate above 10 on Raspberry Pi is not possible. but still there are possibilities to improve the FPS rate by changing the conversion rate from FP64 to INT8.

References

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