DEEP LEARNING BASED SCENE IDENTIFICATION FOR HARD-TO-SEE PEOPLE

A mini project report submitted by

L.CHRISTINA SHERIN with Reg.No :URK19CS1063

in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY
in
COMPUTER SCIENCE AND ENGINEERING

under the supervision of
Kumudha Raimond, Ph.D ,
Professor

COMPUTER SCIENCE AND ENGINEERING

KARUNYA INSTITUTE OF TECHNOLOGY AND SCIENCES

(Declared as Deemed to be University -under Sec-3 of the UGC Act, 1956)
Karunya Nagar, Coimbatore - 641 114. INDIA
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A CHRISTIAN MINORITY RESIDENTIAL INSTITUTION

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that the project report entitled, "**Deep Learning based scene identification for hard to see people**" is a bonafide record of Mini Project work done during the even semester of the academic year 2021-2022 by

L.Christina Sherin (Reg. No: URK19CS063)

in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering of Karunya Institute of Technology and Sciences.

Submitted for the Viva Voce held on ________________

Signature of the Guide

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ABSTRACT

The model takes input test image and based on pre-trained SSD weights , it predicts the output and localizes the segmented image in a boundary box and labels them with their associated class labels. The Confidence-score of the predicted object in a given segment is also displayed for the users to know the accuracy of the object's name.

SSD (Single Shot Multi Box Detector) is an object detection algorithm based on deep learning. As one of the most mainstream detection algorithms, it can greatly improve the detection speed and ensure the detection accuracy. In this project we use SSD algorithm for object detection. The system can select the data to be detected on the front-end page, the detection results and the name of each type of object were displayed on the front-end page in real time. Due to the usage of SSD pre trained weights, our model can able to detect the objects more accurately and clearly.

CONTENTS

CHAPTER-1

Introduction

1.1 Introduction

Object detection is a computer vision technique that works to identify and locate objects within an image or video. Specifically, object detection draws bounding boxes around these detected objects, which allow us to locate where said objects are in (or how they move through) a given scene. Object detection is commonly confused with image recognition, so before we proceed, it’s important that we clarify the distinctions between them.

Image recognition assigns a label to an image. A picture of a dog receives the label “dog”. A picture of two dogs, still receives the label “dog”. Object detection, on the other hand, draws a box around each dog and labels the box “dog”. The model predicts where each object is and what label should be applied. In that way, object detection provides more information about an image than recognition.

1.2 Objectives

- Develop a semantic segmentation and deep learning based model to identify the objects in a given scene
- Recognize the objects and convert it to audio output
- Deploy it in Mobile to assist the visually impaired people

1.3 Motivation

Scene identification is very important for visually impaired people for recognizing the objects that is in front of them, to avoid the risk of accidents and collisions. This model can help the blind to avoid obstacles and move around with confidence.

1.4 Overview of the Project

- A web camera based object recognition system is built using python Open Cv. The system recognizes predefined objects data given by the user as input.
- Image Segmentation plays three important roles in identifying the objects from the given scene
- ### Image Classification

  Image classification is about assigning labels to the image that the system recognizes.
- ### Object Localisation

  The deep learning based model creates a boundary around each object it recognizes and labels them with their respective names.
- ### Object Detection

  It is used to locate the presence of an object along with an axis aligned bounding box indicating the scale and position of every instance of each object.

System Implementation:

This system is implemented using two ways

1.Object Recognition from real time video using webcam

The day to day objects that any person may come across , are given as the input data set. The model recognizes the objects from the input data , localizes them and labels them. The output is detected using web camera.

2.Object Recognition from preloaded video(Mp4 video)

The input dataset is the objects that are found on roadways. A mp4 video of roadside traffic was given to the model to find the objects from the predefined dataset. The recognized objects are localized and labeled.

1.5 Chapter wise Summary

- **MODULE-1**

  Module 1 is about the introduction , the overview and the motivation behind the project.

- **MODULE-2**

  Module 2 is about requirement analysis,design and the architecture behind the project.

- **MODULE-3**

  Module -3 is about the description of the terms used in the project, how the project is implemented and tools used in the project.

- **MODULE-4**

  Module-4 is about verification, validation and testing.

- **MODULE-5**

  Module-5 is about the applications and future scope of the product.

CHAPTER-2

Analysis and Design

2.1 Functional Requirements

User Requirements:

Objective	To assist the hard-to-see people in recognizing the obstacles they come across
Focus	Image segmentation and Object detection using python open Cv
End Result	The Objects in a given scene are detected .
Essentiality	The accuracy of recognizing the object is more as the model is trained with deep learning algorithm.

The user has given a training dataset list. The training dataset are everyday objects and roadside obstacles defined in the form of classes and each detected object from the output are segregated into class variables.

System Requirements:

- The system should have a good quality USB based web camera to capture the scene around them.
- The system should have a preinstalled python Compiler (Latest Version)
- The python version must be able to allow the user to download OpenCV module.

Input: Predefined training datasets in the form of images which are already labeled, predefined class labels.

Output: The images that are recognized from the input are localized with a boundary box around them and the name of the class of the object is displayed around it.

2.2 Non-Functional Requirements

- **Product Requirements:**

  The product must be accessible in any computer.
- **Efficiency Requirements:**

  The efficiency of the model is 80 percent because the model is labeling a series of objects within matter of seconds.
- **Dependency Requirements:**

  Installing Opencv and Tensorflow is mandatory.
- **Security Requirements:**

  There exists some predefined vulnerabilities in open-cv like division by zero error,Out of bound errors, heap buffer overflow and Null pointer dereference which can be resolved by taking proper action.
- **Denial Of Service Attacks**

  Denial of service attack happens in the form of out of bounds error in read function,The validate InputImageSize function allows remote attackers to cause Denial Of Service attack. Segment fault error may occur due to vectors involving incorrect chunks leading to DOS error.
- **Environmental Requirements:**

  The system can run on various OS like windows and Mac.

  The system can run only on Computer but progress are undergoing to make it run on mobile.
- **Development Requirements:**

  The programming language used here is python.

  Space Requirements: The dataset is compressed to save disk space. The frozen_inference graph is compressed and ssd_object weights are also compressed and given as input to the program.

2.3 Architecture

System Architecture

As shown in figure(1) , the input datasets are fed into the preprocessor , the preprocessed data is given to the SSD architecture , the output from the SSD architecture is fed into the Trained model which is tested during the verification phase.

Single Shot MultiBox Detector

The SSD architecture uses object detection method to identify a particular object. VGG-16 base network for SDD is standard CNN architecture for high quality image classification but without the final classification layers. VGG-16 is used for feature extraction.It divides an image into several grids unlike traditional sliding approach , extracts features in 1s and 0s and displays as Feature map.A set of feature map forms a CNN Layer.Relu function is applied to the image to make the image linear as the original image is non-linear.A pooling layer is built on top of CNN.Pooling Layer operates on feature map independently.Flattening occurs after pooling layer **to convert all the resultant 2-Dimensional arrays from pooled feature maps into a single long continuous linear vector**. The flattened matrix is fed as input to the fully connected layer to classify the image.After Flatteing the full connections is made.

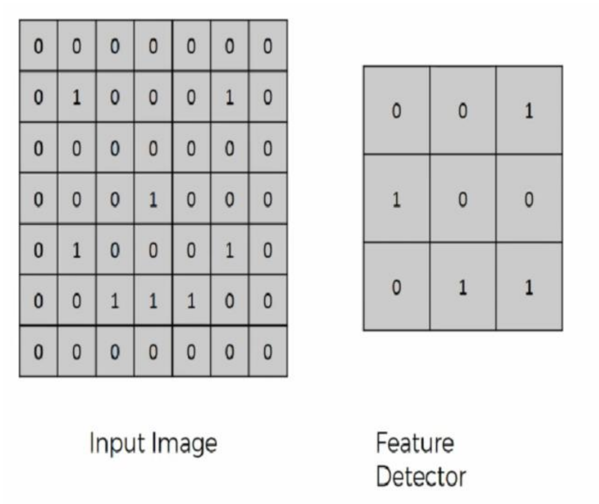


Figure-0(Feature Map)

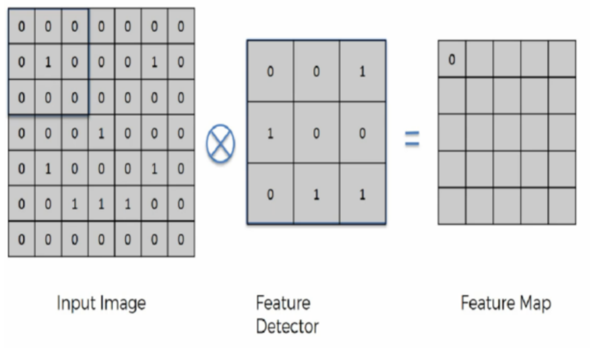


Figure-0.1(Final ANN)

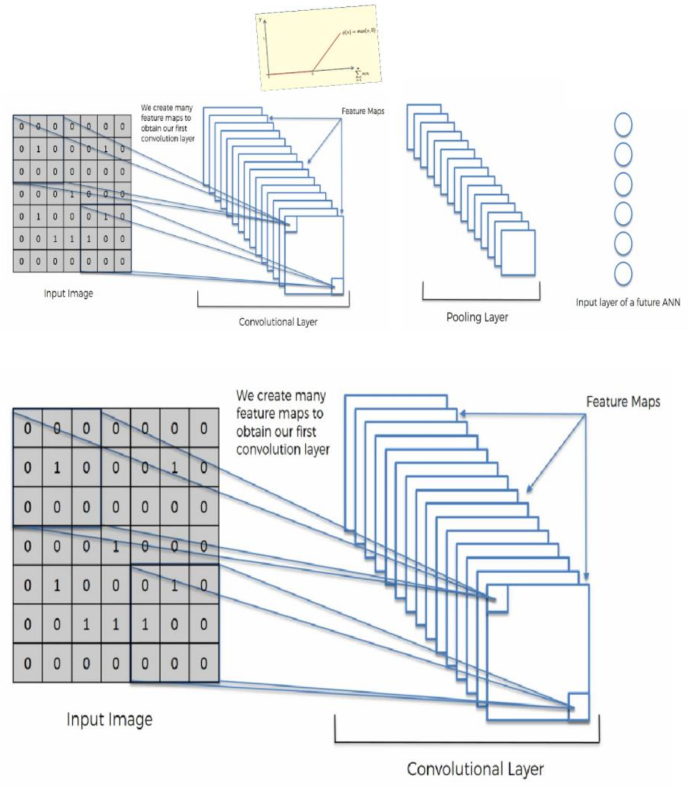


Figure-0.2(Feature Maps and Convolution Layer)

SSD (Single Shot Detector)

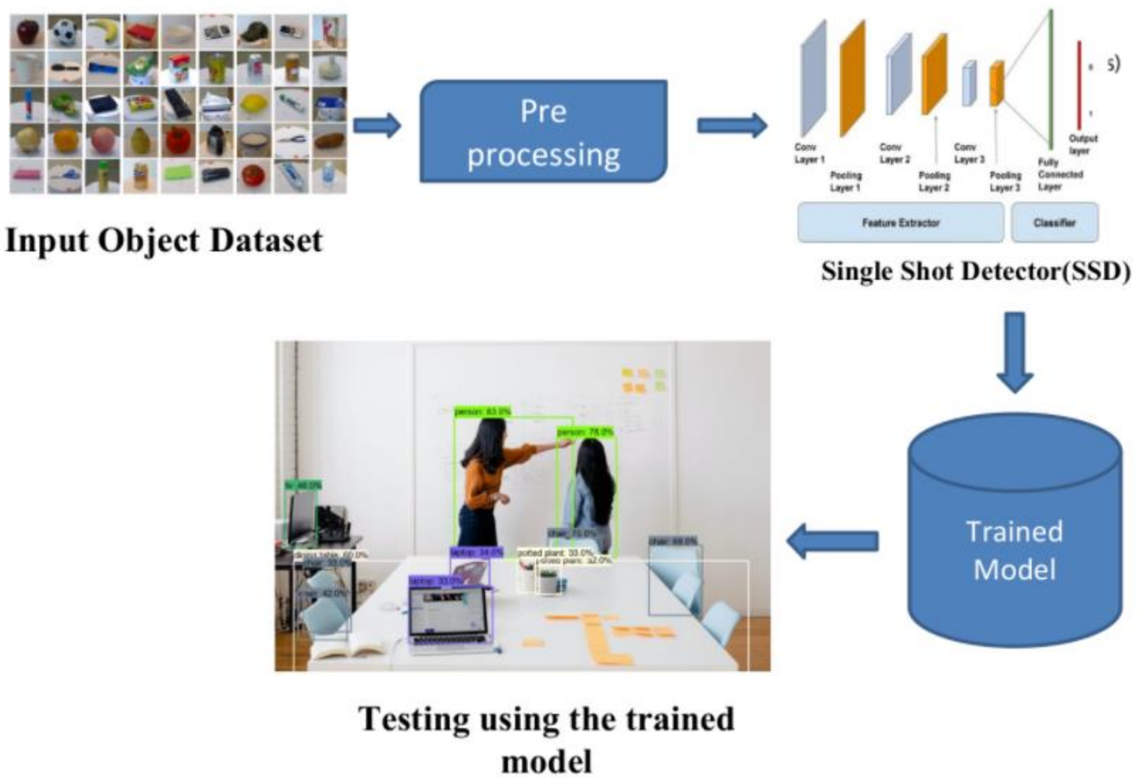
- Single Shot detector like YOLO takes only one shot to detect multiple objects present in an image using multibox.

- It is significantly faster in speed and high-accuracy object detection algorithm.
- High speed and accuracy of SSD using relatively low resolution images is attributed due to following reasons.

- Eliminates bounding box proposals like the ones used in RCNN’s.

- Includes a progressively decreasing convolutional filter for predicting object categories and offsets in bounding box locations.

- High detection accuracy in SSD is achieved by using multiple boxes or filters with different sizes, and aspect ratio for object detection. It also applies these filters to multiple feature maps from the later stages of a network. This helps perform detection at multiple scales.



Figure(1)-System Architecture

SSD architecture is used in this model. SSD has two components.

- Backbone model
- SSD head

SSD Head

- The SSD head is one or more convolution layers added to the backbone and the outputs are interpreted as the bounding boxes and classes of objects in the spatial location of final layers activation.
- SSD divides the images into a grid and have each grid responsible for detecting objects in the region of the image. Detection is all about predicting the class and location of an object within that region.

- **Anchor Box**

  Each grid cell in SSD can be designed with multiple anchor boxes. The anchor boxes are predefined and each one is responsible for size and shape within a grid cell. The anchor box with the highest degree of overlap with an object is responsible for predicting the object's class and its location.

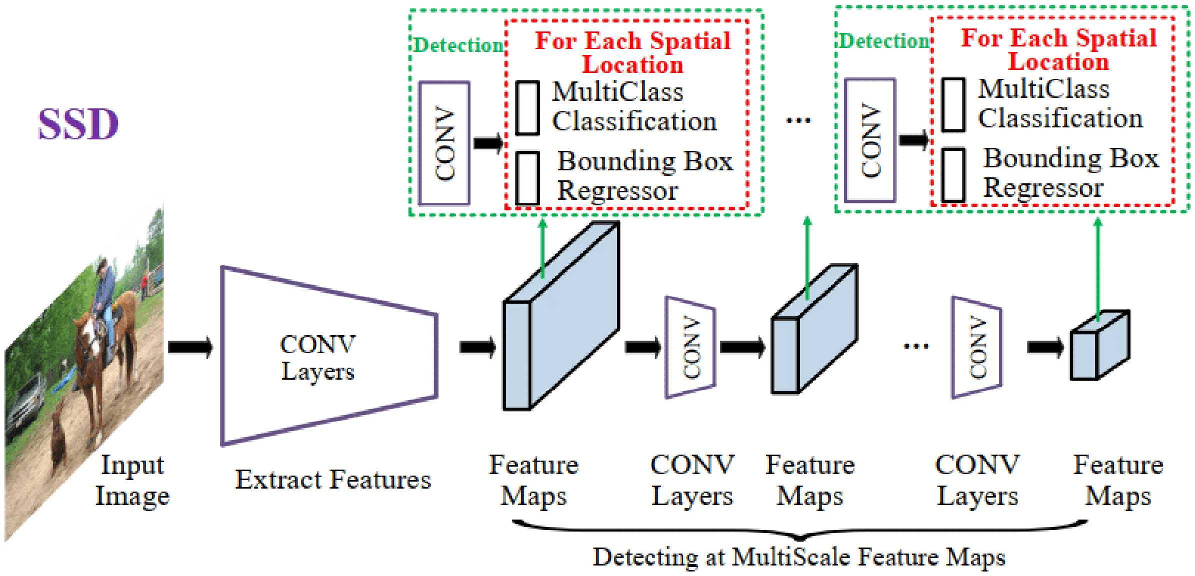
- **Aspect Ratio**

  The ratio aspect can be used to specify the different aspect ratio of anchor box to account for this.

- **Feature Maps**

  Feature corresponds to 7X7 region on the input image. The kind of green and orange 2d arrays are called feature maps. Features in the same feature map has the same receptive field and look for the same pattern but at different locations.
- **Backbone Model**

  Backbone model is a pretrained image classification network which acts as a feature extractor. Usually the fully connected classification layer is removed from the model.

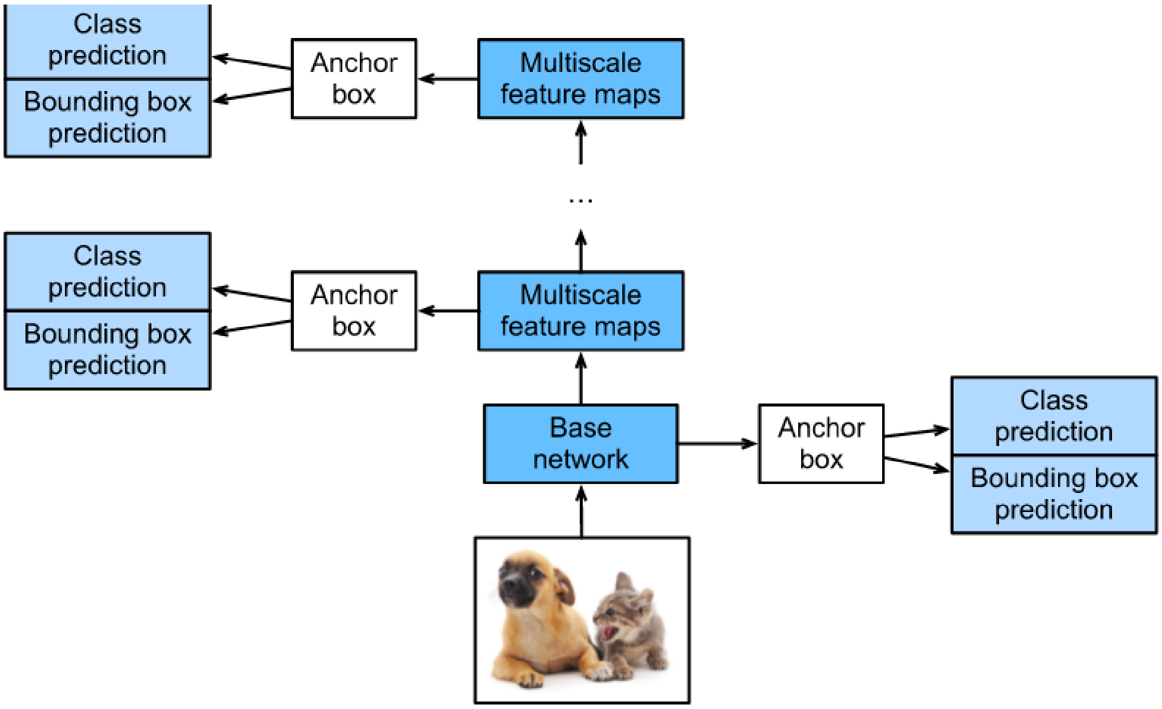


Figure(2)-Architecture of SSD

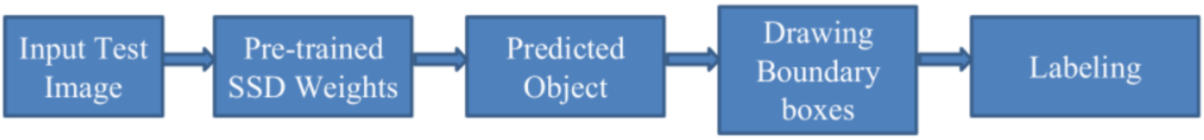
DNN(Deep Neural Network)

- SSD can be implemented using OpenCV's DNN.
- DNN can be used to train and test deep learning models. DNN can be trained using CPUs or GPUs.

2.4 Use case diagram



2.5. Sequence Diagram



CHAPTER-3
Implementation .

3.1. Modules Description

The model involves getting input from training dataset , process it and identify it in the video given as test output.

A convolution neural network called **MobileNetV3** is used.

Mobile Net V3

- MobileNetv3 is a convolution neural network that is turned to mobile phone CPUs through a combination of Hardware network Search (NAS) complemented by the **Netadapt algorithm.**It is a depth wise convolution to reduce the number of parameters.The latest version of this model adds squeeze and excitation layers in the initial building block.It is a pretrainedconvolution neural network.
- The input tensor is given to the model . The data is uncompressed in the Expansion layer. The data is filtered in the Depth wise layer. The data is compressed again in the projection layer. The output tensor is obtained.

VGG-16

VGG is an innovative object recognition model. It supports up to 19 weight layers.

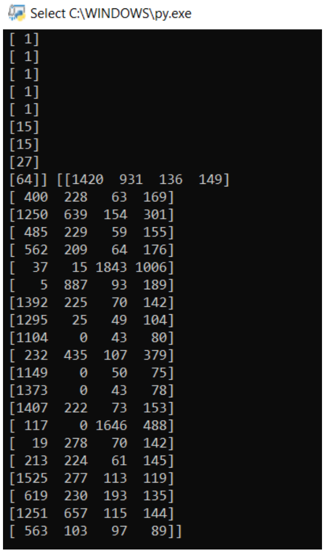
A	A-LRN	B	C	D	E
11 weight layers	11 weight layers	13 weight layers	16 weight layers	16 weight layers	19 weight layers
input (224 × 224 RGB image)					
conv3-64	conv3-64 **LRN**	conv3-64 **conv3-64**	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 **conv3-128**	conv3-128 conv3-128	conv3-128 conv3-128	conv3-128 conv3-128
maxpool					
conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256 **conv1-256**	conv3-256 conv3-256 **conv3-256**	conv3-256 conv3-256 conv3-256 **conv3-256**
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 **conv1-512**	conv3-512 conv3-512 **conv3-512**	conv3-512 conv3-512 conv3-512 **conv3-512**
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 **conv1-512**	conv3-512 conv3-512 **conv3-512**	conv3-512 conv3-512 conv3-512 **conv3-512**
maxpool					
FC-4096					
FC-4096					
FC-1000					
soft-max					

Fonts in OpenCV:

OpenCV has built-in function to add text on images .Open CV also gives a handful of "HERSHEY-FONTS". This model uses **FONT_HERSHEY_COMPLEX which is equivalent to normal size serif font.**

Tensor:

- A tensor is a container which can house data in N dimensions. Often used interchangeably with the matrix, tensors are generalizations of matrices to N-dimensional space.
- As shown in Figure-3,The model converts n-Dimensional tensor to 1D tensor. It represents a multilinear relationship and can be denoted as a potentially multidimensional array.



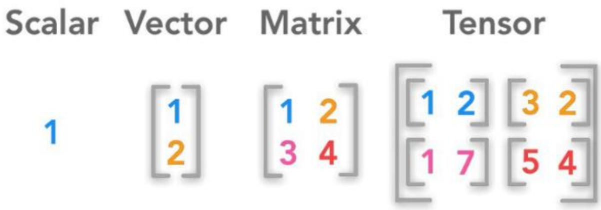


Figure-3(Test Output) Figure-4(Tensor)

- The dimension of a tensor is called its rank. A tensor has shape which is a container that fits our data perfectly and defines the maximum size of our tensor.

Tensor Flow

- Tensor flow first works by building a graph of tf. Tensor objects , detailing how each tensor is computed based on other available tensors and then running the parts of the graph to achieve desired results.

- A layer is a callable object that takes as input one or more tensors and outputs one or more tensors.

Open-CV process

- Images are represented in openCV as numpy arrays.
- Split the images using cv2.split and merge the image back using cv2.merge.

CONVOLUTION LAYER:

Convolution Neural Network consist of multiple layers of Artificial Neurons. Artificial Neurons calculate the weighted sum of multiple inputs and outputs as an activation value. When an image is put in a ConvNet , each layer generates several activation functions that are passed on to the next layer.

The first layer usually extracts basic features such as horizontal or diagonal edges. This output is passed on to next layer which detects more complex features such as corners or combinational edges . As we move deeper it can detect more complex features such as objects and faces. They are regularized versions of multilayer perceptron. CNN extracts the feature from an image
SSD has a base VGG-16 network followed by multibox conv layers
Base neural network: Extracts features

VGG-16 base network for SDD is standard CNN architecture for high quality image classification but without the final classification layers. VGG-16 is used for feature extraction.

Additional Conv Layers: Detect objects

To the base VGG network, we add additional convolutional layers for detection. Convolutional layers at the end of the base network decrease in size progressively. This helps with detection of objects at multiple scales. The convolutional model for detection is different for each feature layer.

Arguments in 2D Convolution Layer

- **Filters:** Integer,the dimensionality of output space
- **Kernel_size:** A list of 2 integers ,specifying the height and width of 2D convolution window.
- **Strides:** A tuple list of 2 integers to specify the value for all spatial dimensions.
- **Padding:** One of "valid" or "same" ."valid" means no padding. "same" results in padding with zeros evenly to left/right or up/down of input.

- **Kernel_initializer:** Initializer for the kernel wights matrix.Kernel_regulizer:Regularizer function applied to the kernel weight matrix.
- **Kernel_constraint:** Constraint function applied to the kernel matrix.
- **Feature Maps**
  Feature corresponds to 7X7 region on the input image. The kind of green and orange 2d arrays are called feature maps. Features in the same feature map has the same receptive field and look for the same pattern but at different locations.
  - **Pooling Layer**
    A pooling layer is another building block of a MNN. Its function is to progressively reduce the spatial size of the representation to reduce the amount of

parameters and computation in the network. Pooling layer operates on each feature map independently.

The most common approach used in pooling is max pooling.

Implementation Details

- **Configure the developer environment**

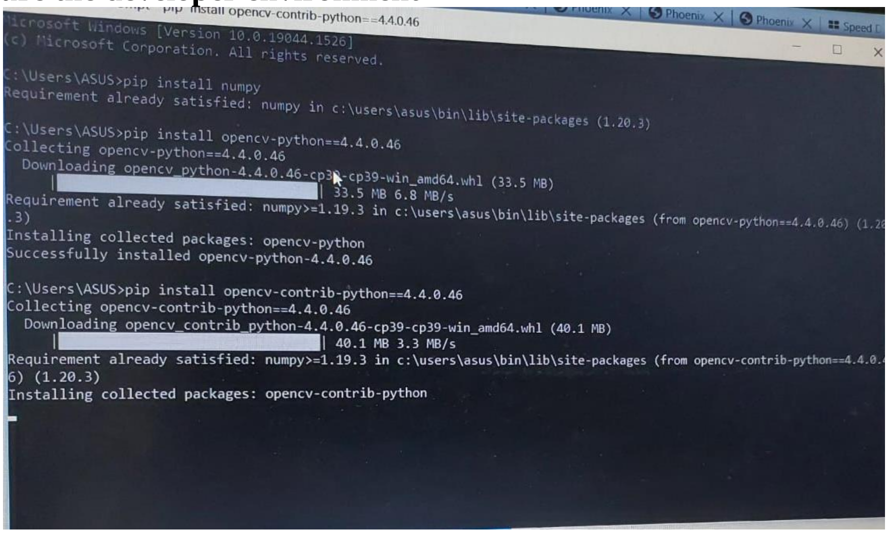


Figure-5(Creating the developer environment in command prompt)

- Pip install opencv
- Pip install numpy
- The model will work only on advanced version of python.The version Python 3.7.6 is used here since this version supports all the libraries from old versions and also from new versions.
- The model uses a predesigned model called **SSD(Single Shot Detector)** architecture. The SSD architecture can be implemented using DNN

video_object_detection.py - C:\Users\ASUS\Documents\Object Detection\object detection final\video_object_detection.py (3.7.6)

File Edit Format Run Options Window Help

```python
import cv2

thres = 0.45 # Threshold to detect object

cap = cv2.VideoCapture('pedestrians.mp4')

cap.set(3,1280)
cap.set(4,720)
cap.set(10,70)

classNames= []
classFile = 'coco.names'
with open(classFile,'rt') as f:
    classNames = f.read().rstrip('\n').split('\n')

configPath = 'i-ssd_object_weights_2021.pbtxt'
weightsPath = 'frozen_inference_graph.pb'

net = cv2.dnn_DetectionModel(weightsPath,configPath)
net.setInputSize(320,320)
net.setInputScale(1.0/ 127.5)
net.setInputMean((127.5, 127.5, 127.5))
net.setInputSwapRB(True)

while True:
    success,img = cap.read()
    classIds, confs, bbox = net.detect(img,confThreshold=thres)
    print(classIds,bbox)

    if len(classIds) != 0:
        for classId, confidence,box in zip(classIds.flatten(),confs.flatten(),bbox):
            cv2.rectangle(img,box,color=(0,255,0),thickness=2)
            cv2.putText(img,classNames[classId-1].upper(),(box[0]+10,box[1]+30),
                        cv2.FONT_HERSHEY_COMPLEX,1,(0,255,0),2)
            cv2.putText(img,str(round(confidence*100,2)),(box[0]+200,box[1]+30),
                        cv2.FONT_HERSHEY_COMPLEX,1,(0,255,0),2)

    cv2.imshow("Output",img)
    cv2.waitKey(1)
```

Figure-6(Video object detection program)

- ➢ Using cv2.capture() from CNN , the input video is invoked as argument.The frame size of the boundary boxes are set.The class names are assigned to an empty array and the input data in form of class labels are read from the file coco.names.as shown in Figure-7

coco.names - Notepad

File Edit Format View Help

```
person
bicycle
car
motorcycle
airplane
bus
train
truck
boat
traffic light
fire hydrant
street sign
stop sign
parking meter
bench
bird
cat
dog
horse
sheep
cow
elephant
bear
zebra
giraffe
hat
backpack
umbrella
shoe
eye glasses
handbag
tie
suitcase
frisbee
skis
snowboard
sports ball
kite
baseball bat
```

Figure-7(Class labels in coco.names file)

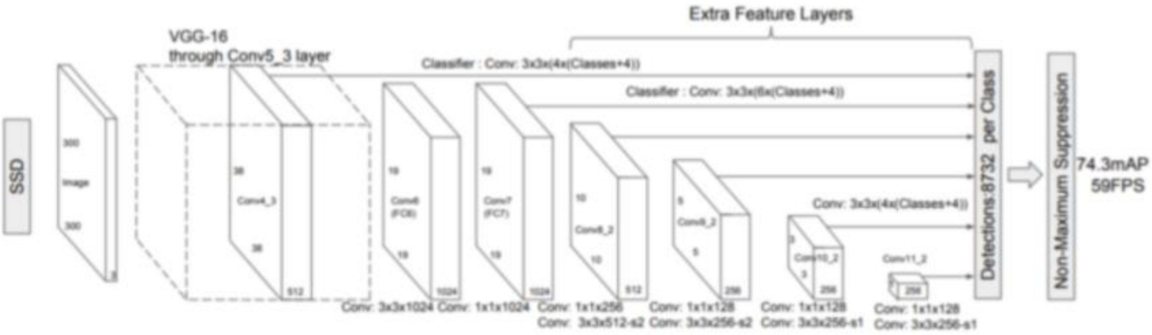


Figure-8(No of Conv layers and extra feature layers)

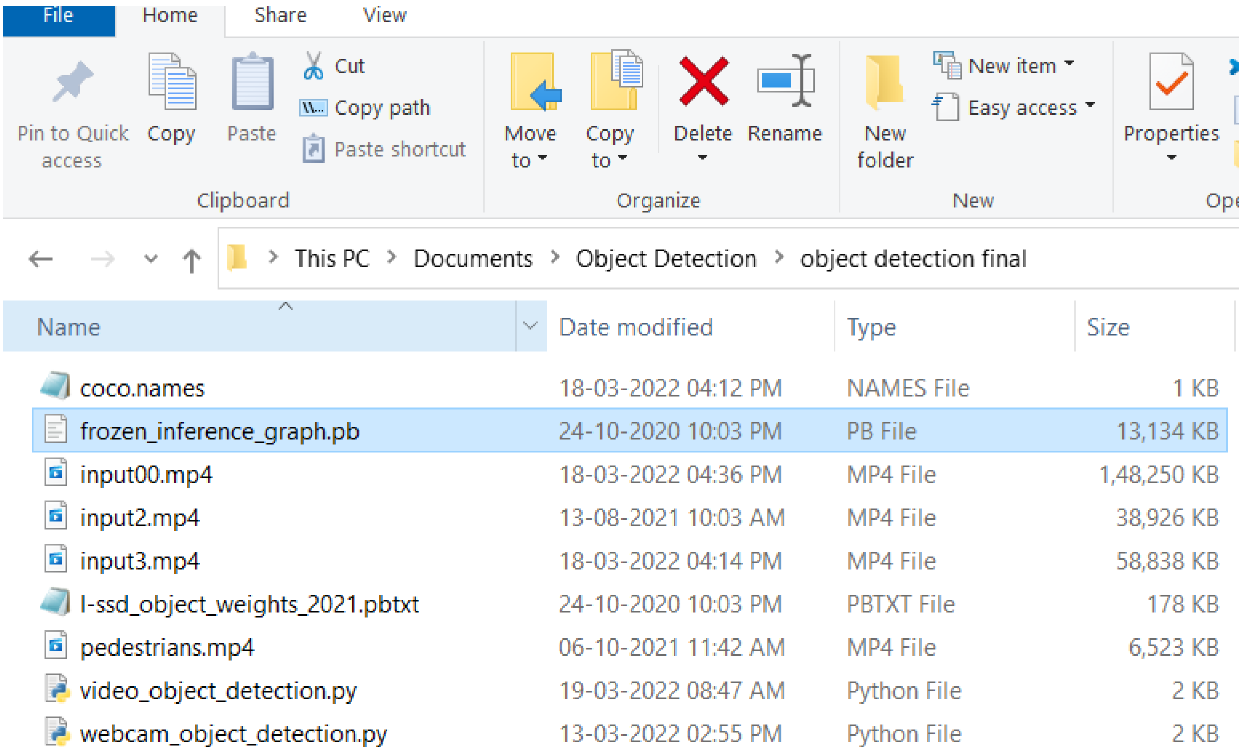


Figure-9(Folder)

- The frozen inference graph and ssd-object weights are predefined library files that has calculated the weight of each node ,listed all the key ,value pairs along with respective input and output of each node and their function. Both of the files are assigned to a particular variable say configpath, weightpath.

- **Detection_model()** is used from Deep Neural Network architecture wherein weightspath and configpath are invoked. The inputsize, inputscale and Input mean were set. The Input SwapRB is set to true. **InputswapRB()** is used to split the image in different colours of red, blue and green.

- The image and text is read from the predefined files.detect() is used to detect the image and the confidential level and class Id and boxes are printed.

- For the data stored in zip files box and thickness are given. Using putText() function the label and the confidence level of the image is displayed in each boundary boxes. The respective variables are invoked in the put Text().The imshow() is used to display the output.

3.3. Tools used

Hardware Tools

- A PC which runs with windows operating system
- **Software Tools**
- Python IDE

Software package

- matplotlib
- Numpy
- Sklearn
- Tensorflow

CHAPTER-4

Test results/experiments/verification

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4.1. Testing and Verification

Image classification in Computer Vision takes an image and predicts the object in an image while object detection not only predicts the object but also finds their location in terms of bounding boxes.

The output of an object detection model include:

- Probability that there is an object
- Height of the bounding box
- Width of the bounding box
- Horizontal coordinate of the center of the bounding box
- Vertical coordinate of the center point of the bounding point

Phase-1: Testing using first input video

The class datasets are given as input under coco.txt file. The model categorizes the identified items into various classes ,localizes it and displays the class label over it. The model also displays the Confidential level of each item based on their class category.

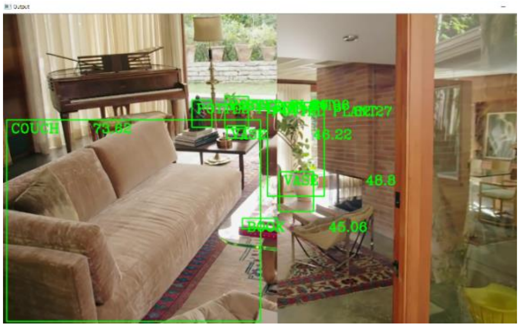
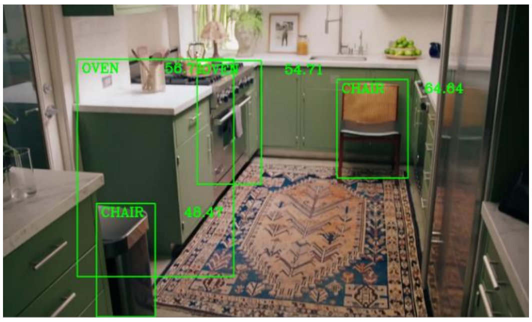
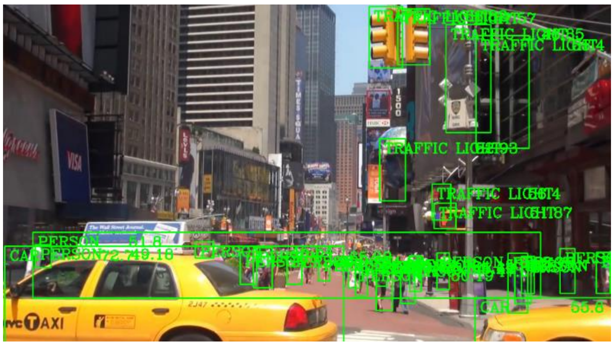
 

Figure- 10(object detection in mp4 video)

Figure-10 consist of every day objects that any person may come across. The model has successfully identified them based on their classes.

Phase-2: Testing with second input video

The second input video consist of objects that can be identified in roadside area.The model has successfully identified the obstacles any person may come across while walking across the streets.

Phase-3:Testing with webcamera

An USB webcamera was attached with the computer system and the program to detect objects in live video was run.

The objects are detected and the boundary boxes are drawn to differentiate them.

4.2.Result

Thus the model is able to segment images, detect them ,localize them , label them and display their confidence level with good accuracy score.

5.CONCLUSION AND FUTURE SCOPE

Image segmentation is used in variety of applications from healthcare to education industries.

Applications:

- Face Recognition
- Sign Language Detection
- Image Segmentation in Medical Images

Future Scope

The product will help the visually impaired to stand on their own legs without needing any human assistance. The text available in the bounding boxes can be converted to speech using Natural Language Processing in Deep Learning and deployed in mobile to assist the blind. For effective performance, the model can be deployed in a system which has higher Graphical User Interface.

Conclusion

Thus deep learning has found its application in assisting the visually impaired to identify the objects they come across in their day to day life .The model can able to predict small objects also.It has high Accuracy and Stability.

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