CHAPTER 1

INTRODUCTION

1.1 Introduction

To limit the spread of an infectious disease, for instance, Covid-19, is to practice social distancing. This is not a new concept, as most societies have been aware of the value of keeping away from people who have been suffering from an infection for many generations. The objective is to reduce transmission, delaying the epidemic peak, reducing the size of the epidemic peak, and spreading cases over a longer time to relieve pressure on the healthcare system. It is an action taken to minimize contact with other individuals. It has been suggested that maintaining a distance of approximately 2 meters from another individual results in a marked reduction in transmission of most flu virus strains, including COVID- 19.

In practice, this means that avoiding close proximity to other people will aid in slowing the spread of infectious diseases. Social distancing is one of the non-pharmaceutical infection control actions that can stop or slow down the spread of a highly contagious disease. The virus that causes COVID-19 is currently spreading easily from person-to-person. When a healthy person comes into contact with respiratory droplets from coughs or sneezes of an infected person, they can catch the infection.

Fig 1.1: Social Distancing

The World Health Organization (WHO) states that "COVID-19 is transmitted via droplets and fomites during close unprotected contact between an infection and infectors.

A fomite is an object or material which is likely to carry infection, such as clothes, utensils, and furniture.

Therefore, transmission of the infection can be avoided by staying away from other people as well as from touching infected fomites. Social distancing aims to decrease or interrupt transmission of COVID-19 in a population by minimizing contact between potentially infected individuals and healthy individuals, or between population groups with high rates of transmission and population groups with no or low levels of transmission. Methods of Social Distancing - Cancellation of events which involve large numbers of people gathering together, such as

- Closure of Community Facilities
- Closure of non-essential workplace
- Closure of schools
- Closure of colleges and universities
- Self-Shielding
- Individuals limit face-to-face contacts
- Individuals avoid public places
- Individuals avoid public transport

Social distancing is a term applied to certain actions that are taken by Public Health officials to stop or slow down the spread of a highly contagious disease. The Health Officer has the legal authority to carry out social distancing measures. Since these measures will have a considerable impact on our community, any action to start social distancing measures would be coordinated with local agencies such as cities, police departments and schools, as well as with state and federal partners[1].

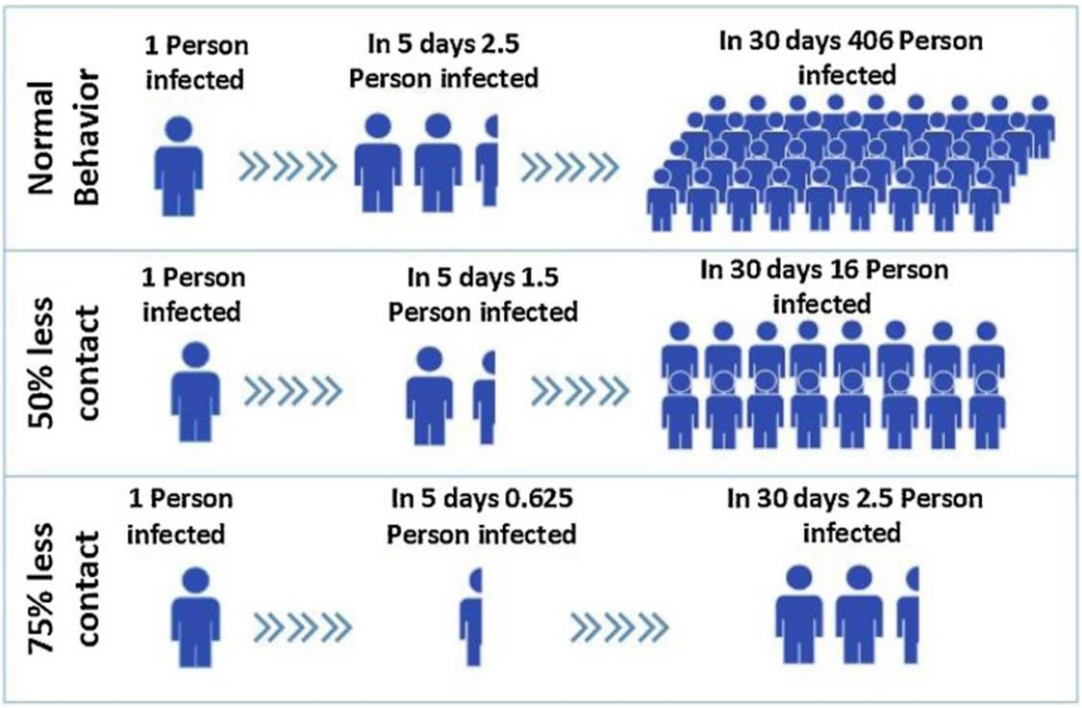

Fig 1.2: Importance of social distance

Social distancing associates with the measures that overcome the virus' spread, by Minimizing the physical contacts of humans, such as the masses at public places (e.g., shopping malls, parks, schools, universities, airports, workplaces), evading crowd gatherings, and maintaining an adequate distance between people. Social distancing is essential, particularly for those people who are at higher risk of serious illness from COVID-19. By decreasing the risk of virus transmission from an infected person to a healthy, the virus' spread and disease severity can be significantly reduced (Statistical) . If social distancing is implemented at the initial stages, it can perform a pivotal role in overcoming the virus spread and preventing the pandemic disease's peak, as illustrated in Fig. 3(Harvard). It can be observed that social distancing can decrease the number of infected patients and reduce the burden on healthcare organizations. It also lowers the mortality rates by assuring that the number of infected cases (patients) does not surpass the public healthcare capability[2].

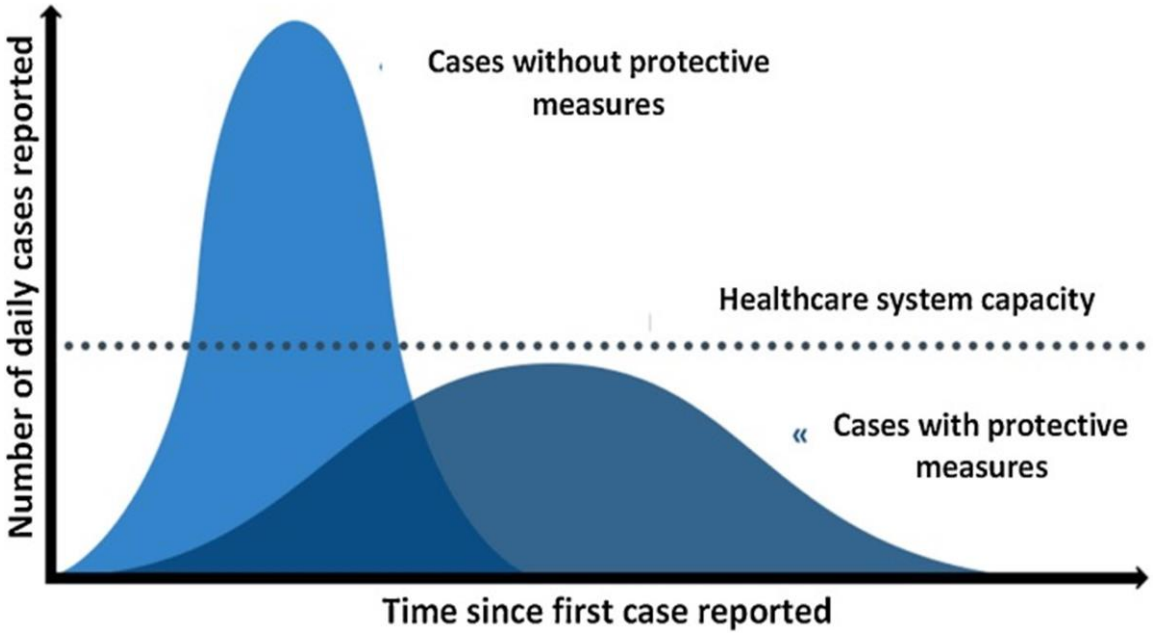

Figure 1.3: Graph of COVID-19 Case

However, monitoring the amount of infection spread and efficiency of the constraints is not an easy task. People require to go out for essential needs such as food, health care and other necessary tasks and jobs. Therefore, many other technology-based solutions such as and AI related research such as have tried to step in to help the health and medical community in copping with COVID-19 challenges and successful social distancing practices. These works vary from GPS-based patient localization and tracking to segmentation, and crowd monitoring.

In such situations, Artificial Intelligence can play an important role in facilitating social distancing monitoring. Computer Vision, as a sub-field of Artificial Intelligence, has been very successful in solving various complex health care problems and has shown its potential in chest CT-Scan or X-ray based COVID-19 recognition and can contribute to Social-distancing monitoring as well. Besides, deep neural networks enable us to extract complex features from the data so that we can provide a more accurate understanding of the images by analyzing and classifying these features. Examples include diagnosis, clinical management and treatment, as well as the prevention and control of COVID-19. Possible challenges in this area are the importance of gaining a high level of accuracy, dealing with a variety of lighting conditions, occlusion, and real-time performance. In this work, we aim at providing solutions to cope with the mentioned challenges, as well. The main contribution of this research can be highlighted as follows:

- This study aims to support the reduction of the coronavirus spread and its economic costs by providing an AI-based solution to automatically monitor and detect violations of social distancing among individuals.
- We develop a robust deep neural network (DNN) model for people detection, tracking, and distance estimation called Deep SOCIAL (Sections 3.1–3.3). In comparison with some recent works in this area, such as 1., we offer faster and more accurate results
- We perform a live and dynamic risk assessment, by statistical analysis of spatio-temporal data from the people movements at the scene (Section 4.4). This will enable us to track the moving trajectory of people and their behaviours, to analyse the ratio of the social distancing violations to the total number of people in the scene, and to detect high-risk zones for short- and long-term periods.

1.2 Introduction about COVID-19

Coronaviruses are zoonotic. This means they first develop in animals before developing in humans. For the virus to pass from animal to humans, a person has to come into close contact with an animal that carries the infection. Once the virus develops in people, coronaviruses can be spread from person to person through respiratory droplets.

This is a technical name for the wet stuff that moves through the air when you cough or sneeze. The viral material hangs out in these droplets and can be breathed into the respiratory tract (your windpipe and lungs), where the virus can then lead to an infection. 1 Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus.

The virus that causes COVID-19 is mainly transmitted through droplets generated when an infected person coughs, sneezes, or exhales. These droplets are too heavy to hang in the air, and quickly fall on floors or surfaces.

People can be infected by breathing in the virus if you are within close proximity of someone who has COVID-19, or by touching a contaminated surface and then your eyes, nose or mouth. Most people who fall sick with COVID-19 will experience mild to moderate symptoms and recover without special treatment.

Common symptoms:

- Fever.

- Tiredness.
- Dry cough.

Some people may experience:

- Aches and pains.
- Nasal congestion.
- Runny nose.
- Sore throat.
- Diarrhoea.

On average it takes 5–6 days from when someone is infected with the virus for symptoms to show, however it can take up to 14 days.

Older people and people with certain health conditions have a higher risk for severe complications if they contract the virus.

These health conditions include lung conditions, such as COPD and asthma

- certain heart conditions
- immune system conditions, such as HIV
- cancer that requires treatment
- severe obesity
- other health conditions, if not well-controlled, such as diabetes, kidney disease, or liver disease

To prevent the spread of COVID-19:

Avoid large events and mass gatherings.

- Avoid close contact (within about 6 feet, or 2 meters) with anyone who is sick or has symptoms.
- Stay home as much as possible and keep distance between yourself and others (within about 6 feet, or 2 meters) if COVID-19 is spreading in your community, especially if you have a higher risk of serious illness. Keep in mind some people may have COVID-19 and spread it to others, even if they don't have symptoms or don't know they have COVID-19.

- Wash your hands often with soap and water for at least 20 seconds, or use an alcohol-based hand sanitizer that contains at least 60% alcohol.
- Cover your face with a cloth face covering in public spaces, such as the grocery store, where it's difficult to avoid close contact with others, especially if you're in an area with ongoing community spread. Only use nonmedical cloth masks surgical masks and N95 respirators should be reserved for health care providers.
- Cover your mouth and nose with your elbow or a tissue when you cough or sneeze. Throw away the used tissue.
- Avoid touching your eyes, nose and mouth.
- Avoid sharing dishes, glasses, bedding and other household items if you're sick.
- Clean and disinfect high-touch surfaces daily.
- Stay home from work, school and public areas if you're sick, unless you're going to get medical care. Avoid taking public transportation if you're sick.

1.3 Artificial Intelligence

Artificial intelligence (AI), sometimes called machine intelligence, is intelligence demonstrated by machines, Leading AI define the field as the study of "intelligent agents" any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals. Colloquially, the term "artificial intelligence" is often used to describe machines (or computers) that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem solving".

Fig 1.4: Artificial Intelligences

As machines become increasingly capable, tasks considered to require "intelligence" are often removed from the definition of AI, a phenomenon known as the AI affect "AI is whatever hasn't been done yet. For instance, optical character recognition is frequently excluded from things considered to be AI, having become a routine technology. Modern machine capabilities generally classified as AI include understanding human speech, competing at the highest, autonomously operating cars, intelligent routing in content delivery networks, and military simulations.

Social Distancing Alert System AI platform uses existing IP cameras to identify if people are following social distancing. Social Distancing Computer Vision system finds the gap between two persons detected in the camera. The platform generates notifications and calls an external alarm (via speaker) to warn if anyone is found violating laws.

1.4 Deep learning

Deep learning is a machine learning method that allows computers to mimic the human brain, usually to complete classification tasks on images or non-visual data sets in present days deep learning is used in driving cars, artificial intelligence programs, and beyond. These technologies are in high demand, it is similar to human brain. Advantages: Unstructured data handling, Recognize unexpected[3].

1.5 Numpy

NumPy is the fundamental package for scientific computing in Python. It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more.

At the core of the NumPy package, is the ndarray object. This encapsulates *n*-dimensional arrays of homogeneous data types, with many operations being performed in compiled code for performance. There are several important differences between NumPy arrays and the standard Python sequences:

- NumPy arrays have a fixed size at creation, unlike Python lists (which can grow dynamically). Changing the size of an ndarray will create a new array and delete the original.

- The elements in a NumPy array are all required to be of the same data type, and thus will be the same size in memory. The exception: one can have arrays of (Python, including NumPy) objects, thereby allowing for arrays of different sized elements.
- NumPy arrays facilitate advanced mathematical and other types of operations on large numbers of data. Typically, such operations are executed more efficiently and with less code than is possible using Python's built-in sequences.
- A growing plethora of scientific and mathematical Python-based packages are using NumPy arrays; though these typically support Python-sequence input, they convert such input to NumPy arrays prior to processing, and they often output NumPy arrays. In other words, in order to efficiently use much (perhaps even most) of today's scientific/mathematical Python-based software, just knowing how to use Python's built-in sequence types is insufficient - one also needs to know how to use NumPy arrays.

5.1.1 Why is NumPy Fast?

Vectorization describes the absence of any explicit looping, indexing, etc., in the code - these things are taking place, of course, just "behind the scenes" in optimized, pre-compiled C code. Vectorized code has many advantages, among which are:

- vectorized code is more concise and easier to read
- fewer lines of code generally means fewer bugs
- The code more closely resembles standard mathematical notation (making it easier,typically, to correctly code mathematical constructs)
- vectorization results in more "Pythonic" code. Without vectorization, our code would be littered with inefficient and difficult to read for loops.

Broadcasting is the term used to describe the implicit element-by-element behavior of operations; generally speaking, in NumPy all operations, not just arithmetic operations, but logical, bit-wise, functional, etc., behave in this implicit element-by-element fashion, i.e., they broadcast. Moreover, in the example above, a and b could be multidimensional arrays of the same shape, or a scalar and an array, or even two arrays of with different shapes, provided that the smaller array is "expandable" to the shape of the larger in such a way that the resulting broadcast is unambiguous. For detailed "rules"

1.5.2 Operations using NumPy

Using NumPy, a developer can perform the following operations −

- Mathematical and logical operations on arrays.
- Fourier transforms and routines for shape manipulation.
- Operations related to linear algebra. NumPy has in-built functions for linear algebra and random number generation.

1.6 OpenCV

OpenCV Python is a library of Python bindings designed to solve computer vision problems. Python is a general purpose programming language started by Guido van Rossum that became very popular very quickly, mainly because of its simplicity and code readability. It enables the programmer to express ideas in fewer lines of code without reducing readability. Compared to languages like C/C++, Python is slower. That said, Python can be easily extended with C/C++, which allows us to write computationally intensive code in C/C++ and create Python wrappers that can be used as Python modules. This gives us two advantages: first, the code is as fast as the original C/C++ code (since itis the actual C++ code working in background) and second, it easier to code in Python than C/C++. OpenCV-Python makes use of Numpy, which is a highly optimized library for numerical operations with a MATLAB-style syntax. All the OpenCV array structures are converted to and from Numpy arrays. This also makes it easier to integrate with other libraries that use Numpy[5].

1.7 Argparse

Definition: Argparse is a complete argument *processing* library. Arguments can trigger different actions, specified by the action argument to add_argument(). Supported actions include storing the argument (singly, or as part of a list), storing a constant value when the argument is encountered (including special handling for true/false values for Boolean switches), counting the number of times an argument is seen, and calling a callback.

The default action is to store the argument value. In this case, if a type is provided, the value is converted to that type before it is stored. If the dest argument is provided, the value is saved to an attribute of that name on the Namespace object returned when the command line arguments are parsed.

Python argparse is a command-line parsing module that is recommended to work with the command line argument. This module was released as a part of the standard library with Python on 20th February 2011.

The argparse module in python helps create a program in a command-line-environment in a way that appears not only easy to code but also improves interaction. The argparse module also automatically generates help and usage messages and issues errors when users give the program invalid arguments.

It provides a few important features that are given below.

- It allows us to use to positional argument.
- It allows us to customize the prefix chars.
- It supports variable numbers of parameters for a single option.
- It supports subcommands.

Types of Argument in Command Line Interface.

There are two arguments that we can add to the command-line interface.

- Positional Argument
- Optional Argument

Positional Argument - Positional arguments are the types of argument that we use in command to operate. We pass the argument to the command and perform some operations. Their position defines by their function. That's why they are called a positional argument. By default, the positional arguments are treated as String, however we can typecast in other data types.

Optional Argument - Optional Argument are not mandatory. We will not get the error if not passed to the script. These types of arguments are started with the - single dash or "--" double dash prefix. We need to call the **.**add_parse() to pass the optional argument[2].

1.8 Organization of report

The seminar report is organized as follows:

Chapter 1: Includes the introduction of Artificial intelligence, Deep learning, and python packages.

Chapter 2: Deals with the Literature survey of the related topic and brief about SSD and its architecture.

Chapter 3: Describes the problem statement and objectives.

Chapter 4: Describes the methodology, software requirments, hardware components and block diagram.

Chapter 5: Describes the results and its comparison, advantages, disadvantages, applications and future scope.

Chapter 6: Summary of the project i.e. conclusion and finally the references.

CHAPTER 2

LITERATURE SURVEY

After the rise of the COVID-19 pandemic since late December 2019, social distancing is deemed to be the utmost reliable practice to prevent the contagious virus transmission and opted as standard practice on January 23, 2020. During one month, the number of cases rises exceptionally, with two thousand to four thousand new confirmed cases reported per day in the first week of February 2020. Later, there was a sign of relief for the first time for five successive days up to March 23, 2020, with no new confirmed cases. This is because of the social distance practice initiated in China and, latterly, adopted by worldwide to control COVID-19. investigated the relationship between the region's economic situation and the social distancing strictness. The study revealed that moderate stages of exercise could be allowed for evading a large outbreak. So far, many countries have used technology-based solutions to overcome the pandemic loss. Several developed countries are employing GPS technology to monitor the movements of infected and suspected individuals. provides a survey of different emerging technologies, including Wi-fi, Bluetooth, smartphones, and GPS, positioning (localization), computer vision, and deep learning that can play a crucial role in several practical social distancing scenarios. Some researchers utilize drones and other surveillance cameras to detect crowded gatherings.

Until now, researchers have done considerable work on detection, some provides a smart healthcare system for pandemics using the Internet of Medical Things, studied the social distancing impacts on the spread of the COVID-19 outbreak. The studies concluded that the early and immediate practice of social distancing could gradually reduce the peak of the virus attack. As we all know, although social distancing is crucial for flattening the infection curve, it is an economically unpleasant step. Adolph et al. highlighted the United States of America's condition during the pandemic. Due to a lack of general support by decision-makers, it was not implemented at an initial stage, starting harm to public health. However, social distancing influenced economic productivity; even then, numerous scholars sought alternatives that overcame the loss.

Researchers provide effective solutions for social distance measuring using surveillance videos along with computer vision, machine learning, and deep learning-based approaches. proposed a framework using the YOLOv3 model to detect humans

and the Deep sort approach to track the detected people using bounding boxes and assigned ID information. They used an open image data set (OID) repository, a frontal view data set. The authors also compared results with faster-RCNN and SSD. developed an autonomous drone-based model for social distance monitoring. They trained the YOLOv3 model with a custom data set. The data set is composed of frontal and side - view images of limited people. The work is also extended to the monitoring of facial masks. The drone camera and the YOLOv3 algorithm help identify the social distance and monitor people from the side or frontal view in public wearing masks. Suggested an efficient graph-based monitoring framework for physical distancing and crowd management. performed human detection in a crowded situation. The model is designed for individuals who do not obey a social distance restriction, i.e., 6 feet of space between them. The authors used a mobile robot with an RGB-D camera and a 2-D to make collision-free navigation in mass gatherings.

From the literature, we concluded that the researcher had done a considerable amount of work for monitoring of social distances in public environments. But, most of the work is focused on the frontal or side view camera perspective. Therefore, in this work, we presented an overhead view social distance monitoring framework that offers a better field of view and overcomes the issues of occlusion, thereby playing a key role in social distance monitoring to compute the distance between peoples.

2.1 OpenCV

Officially launched in 1999 the OpenCV project was initially an Intel Research initiative to advance CPU-intensive applications, part of a series of projects including real-time raytracing and 3D display walls. The main contributors to the project included a number of optimization experts in Intel Russia, as well as Intel's Performance Library Team. In the early days of OpenCV, the goals of the project were described as:

- Advance vision research by providing not only open but also optimized code for basic vision infrastructure. No more reinventing the wheel.
- Disseminate vision knowledge by providing a common infrastructure that developers could build on, so that code would be more readily readable and transferable.

- Advance vision-based commercial applications by making portable, performance-optimized code available for free – with a license that did not require code to be open or free itself.

The first alpha version of OpenCV was released to the public at the IEEE Conference on Computer Vision and Pattern Recognition in 2000, and five betas were released between 2001 and 2005. The first 1.0 version was released in 2006. A version 1.1 "pre-release" was released in October 2008.

The second major release of the OpenCV was in October 2009. OpenCV2 includes major changes to the C++ interface, aiming at easier, more type-safe patterns, new functions, and better implementations for existing ones in terms of performance (especially on multi-core systems). Official releases now occur every six months and development is now done by an independent Russian team supported by commercial corporations.

In August 2012, support for OpenCV was taken over by a non-profit foundationOpenCV.org, which maintains a developer and user site.

On May 2016, Intel signed an agreement to acquire It seez, a leading developer of OpenCV.

In July 2020, OpenCV announced and began a Kick starter campaign for the Open CV AI Kit, a series of hardware modules and additions to OpenCV supporting Spatial AI.

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library.

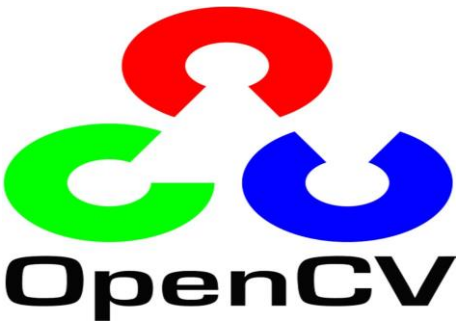

Figure 2.1: logo of openCV

OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSDlicensed product, OpenCV makes it easy for businesses to utilize and modify the code.

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together toproduce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 18 million. The library is used extensively in companies, research groups and by governmental bodies.

Along with well-established companies like Google, Yahoo, Microsoft, Intel, IBM, Sony, Honda, Toyota that employ the library, there are many startups such as Applied Minds, Video Surf, , that make extensive use of OpenCV. OpenCV's deployed uses span the range from stitching street view images together, detecting intrusions in surveillance video in Israel, monitoring mine equipment in China, helping robots navigateand pick up objects at Willow Garage, detection of swimming pool drowning accidents in Europe, running interactive art in Spain and New York, checking runways for debris in Turkey, inspecting labels on products in factories around the world on to rapid face detection in Japan.

It has C++, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS. OpenCV leans mostly towards real-time vision applications and takes advantage of MMX and SSE instructions when available. A full-featured CUDA and OpenCL interfaces are being actively developed right now. There are over 500 algorithms and about 10 times as many functions that compose or support those algorithms. OpenCV is written natively in C++ and has a templated interface that works seamlessly with STL containers.

SSD Object Detection in Real Time (Deep Learning and Caffe)

Here we will be talking about SSD Object Detection- features, advantages, drawbacks, and implement MobileNet SSD model with Caffe - using OpenCV in Python[6].

What is Object Detection?

Object Detection in Computer Vision is as simple as it sounds- detecting and predicting objects and localizing their area. Object Detection is based on image classification.Irrespective of the latter being performed using neural networks *or* primitive classifiers, image classification is always the first step. Building further on this, we can perform detection which localizes all possible objects in a given frame.

Single Shot Detector (SSD)

SSD Object Detection extracts feature map using a base deep learning network**,** which are CNN based classifiers, and applies convolution filters to finally detect objects. Our implementation uses MobileNet as the base network (others might include- VGGNet, ResNet, DenseNet).

SSD is an object detection model, but what exactly does object detection mean?

A lot of people confuse object detection with image classification. In simple words, image classification says what the picture or image is, while object detection finds out the different things in the image and tells where they are in the image with the help of bounding boxes. With that cleared let's jump into SSD.

The famous single shot detectors are YOLO(you look only once) and Single Shot multibox detector. We will be discussing the SSD with a single-shot multibox detector since it is a more efficient and faster algorithm than the YOLO algorithm

Single Shot detector the name of the model itself reveals most of the details about the model. Yes, the SSD model detects the object in a single pass over the input image, unlike other models which traverse the image more than once to get an output detection.

What makes SSD special?

As said above the SSD model detects objects in a single pass, which means it saves a lot of time. But at the same time, the SSD model also seems to have amazing accuracy in its detection[6].

In order to achieve high detection accuracy, the SSD model produces predictions at different scales from the feature maps of different scales and explicitly separates predictions by aspect ratio.

Structure / Architecture of SSD model

The SSD model is made up of 2 parts namely

1. The backbone model.
2. The SSD head.

The Backbone model is a typical pre-trained image classification network that works as the feature map extractor. Here, the image final image classification layers of the model are removed to give us only the extracted feature maps.

SSD head is made up of a couple of convolutional layers stacked together and it is added to the top of the backbone model. This gives us the output as the bounding boxes over the objects. These convolutional layers detect the various objects in the image.

How does SSD work?

The SSD is based on the use of convolutional networks that produce multiple bounding boxes of various fixed sizes and scores the presence of the object class instance in those boxes, followed by a non-maximum suppression step to produce the final detections.

The SSD model works as follows, each input image is divided into grids of various sizes and at each grid, the detection is performed for different classes and different aspect ratios. And a score is assigned to each of these grids that says how well an object matches in that particular grid. And non-maximum suppression is applied to get the final detection from the set of overlapping detections. This is the basic idea behind the SSD model Here we use different grid sizes to detect objects of different sizes, for example, look at the image given below when we want to detect the cat smaller grids are used but when we want to detect a dog the grid size is increased which makes the SSD more efficient[7].

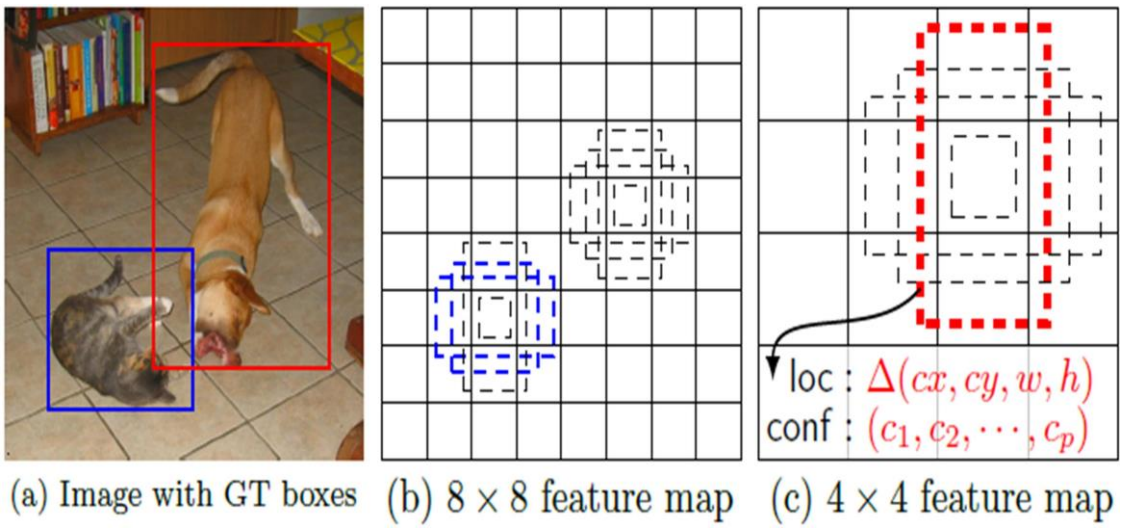

Figure 2.2: Feature Maps

Detections using multi-scale feature maps

The multi-scale feature maps are added to the end of the truncated backbone model. These multi-scale feature maps reduce in size progressively, which allows the detections at various scales of the image. The convolutional layers used here vary for each feature layer.

Detection using the convolutional predictors

The addition of each extra layer produces a fixed number of predictions using the convolutional filters in them. These additional layers are shown at the top of the model in the given diagram below. For example, a feature layer of size m x n with p channels, the minimal prediction parameter that gives a decent detection is a 3 x 3 x p small kernel. Such kernel gives us the score for a category or a shape offset relative to the default box coordinates

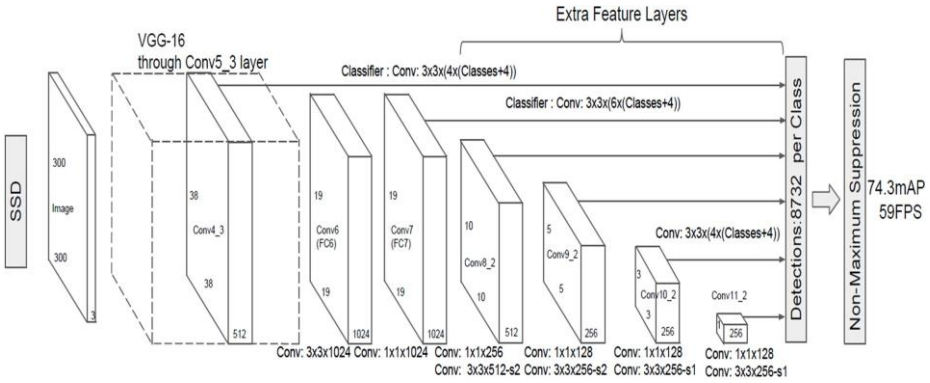

Figure 2.3: Architecture of SSD

Usage of Default Boxes and aspect ratios

The default bounding boxes are associated with every feature map cell at the top of the network. These default boxes tile the feature map in a convolutional manner such that the position of each box relative to its corresponding cell is fixed

For each box out of k at a given location, c class scores are computed and 4 offset relatives to the original default box shape. This results in the total of (C+4)k filters that are applied around each location in the feature map, yielding (C+4)k outputs for a feature map of size mxm his allows the usage of different default box shapes in several feature maps and makes the model efficiently discretize the space of possible output box shapes.

YOLO vs SSD

The You look only once (YOLO) model is a predecessor to the SSD model, it also detectsimages in a single pass, but it uses two fully connected layers while the SSD uses multiple convolutional layers. The SSD model adds several feature layers to the end of a base network, which predicts the offsets to default boxes of different scales and aspect ratios and their associated scores[8].

The SSD produces an average of 8732 detections per class while the YOLO produces only 98 predictions per class. An SSD with a 300 x 300 inputs size significantly outperforms a 448 x 448 YOLO counterpart in accuracy as well as speed in the VOC2007 test[9].

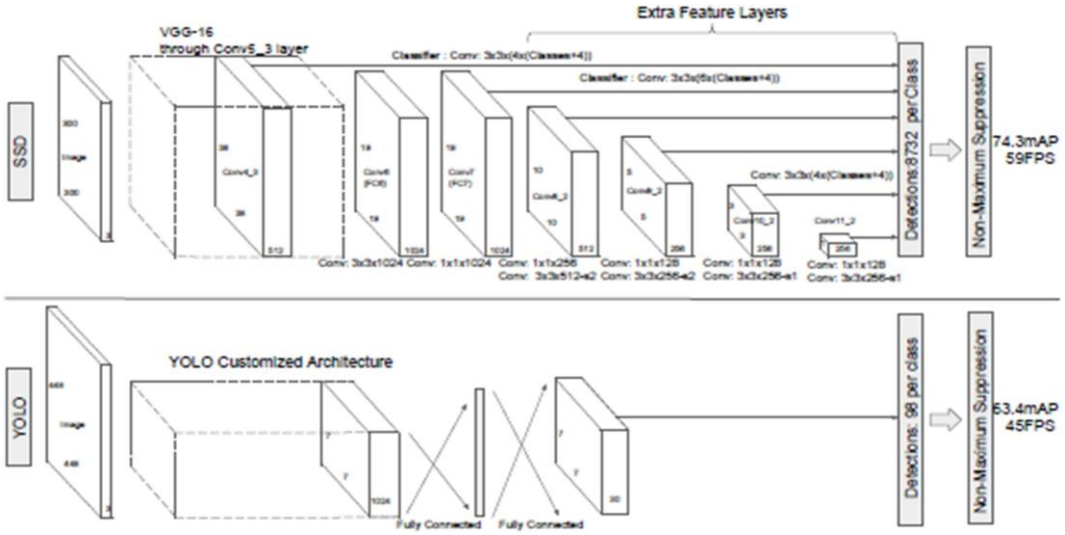

Figure 2.4: The image compares the SSD model with a YOLO model

Performance of SSD

The SSD model is proven to show better results than the previous state-of-the-art detection algorithms like YOLO and Faster R-CNN. The multi-output layers at different resolutions have impacted the performance hugely, in fact, even removal of few layers resulted in a decrease in the accuracy by 12%[10].

System	VOC2007 test mAP	FPS(Titan X)	Number of Boxes	Input resolution
Faster R-CNN(VGG16)	73.2	7	~6000	~1000×600
YOLO(customized)	63.4	45	98	448×448
SSD300*(VGG16)	77.2	46	8732	300×300
SSD512*(VGG16)	79.8	19	24564	512×512

Table2.1: Performance comparison among object detection networks.

The SSD model is one of the fastest and efficient object detection models for multiple categories. And it has also opened new doors in the domain of object detection. With this article at Open Genus, you must have the complete idea of SSD.

What is Caffe?

Caffe is a deep learning framework developed by Berkeley AI Research and community contributors. Caffe was developed as a faster and far more efficient alternative to other frameworks to perform object detection. Caffe can process **60** million images per day with a single NVIDIA K-40 GPU. That is 1ms/image for inference and 4 ms/image for learning[11].

CHAPTER 3

PROBLEM DEFINITION

3.1 Existing work

Running the program will give you frame (first frame) where you need to draw ROI and distance scale. To get ROI and distance scale points from first frame Code to transform perspective to Bird's eye view (Top view) and to calculate horizontal and vertical 180 cm distance in Bird's eye view ROI and Scale points' selection for first frame. The second step is to detect pedestrians and draw a bounding box around each pedestrian. To detect humans in video and get bounding box details. Now we have a bounding box for each person in the frame. We need to estimate a person 's location in the frame. means we can take the bottom center point of the bounding box as a person 's location in frame. Then we estimate (x, y) location in bird's eye view by applying transformation to the bottom center point of each person's bounding box, resulting in their position in the bird's eye view. To calculate the bottom center point for all bounding boxes and project those pointsinto a Bird's eye view. The last step is to compute the bird's eye view distance between every pair of people (Point) and scale the distances by the scaling factor in horizontal and vertical directions estimated from calibration.

Lastly, we can draw a Bird's Eye View for region of interest (ROI) and draw bounding boxes according to risk factor for humans in a frame and draw lines between boxes according to risk factor between two humans. Red, Yellow, Green points represent risk to humans in a Bird's eye view. Red: High Risk, and Green: No Risk. Red, Yellow lines between two humans in output tell they are violating social distancing rules[12].

3.2 Problem statement

This social distancing detector did not leverage proper camera calibration, meaning that we could not (easily) map distances in pixels to actual measurable units (i.e., meters, feet, etc.).

Therefore, the first step to improving our social distance detector is to utilize proper camera calibration. Doing so will yield better results and enable you to compute actual measurable units (rather than pixels).

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3.3 Objectives

The main objective of our system is that will identify weather the person in frame is maintaining distance between two people. This system Social distance detector is to prevent the spread of disease. using computer vision technology based On Open CV and SSD -based deep learning. The system provides one bounding box for identify the person. If the person in frame should maintain minimum of 3 feet distance then our system will put a green bounding box across the person, else bounding box will be in red colour. Status is shown in the screen, containing number of people in frame and numberof people who are not maintaining distance of 3 feet will be displayed in status barthat bottom of the screen**.** Our proposed model can be integrated with the camera[13].

CHAPTER 4

METHODOLOGY

4.1 Proposed system

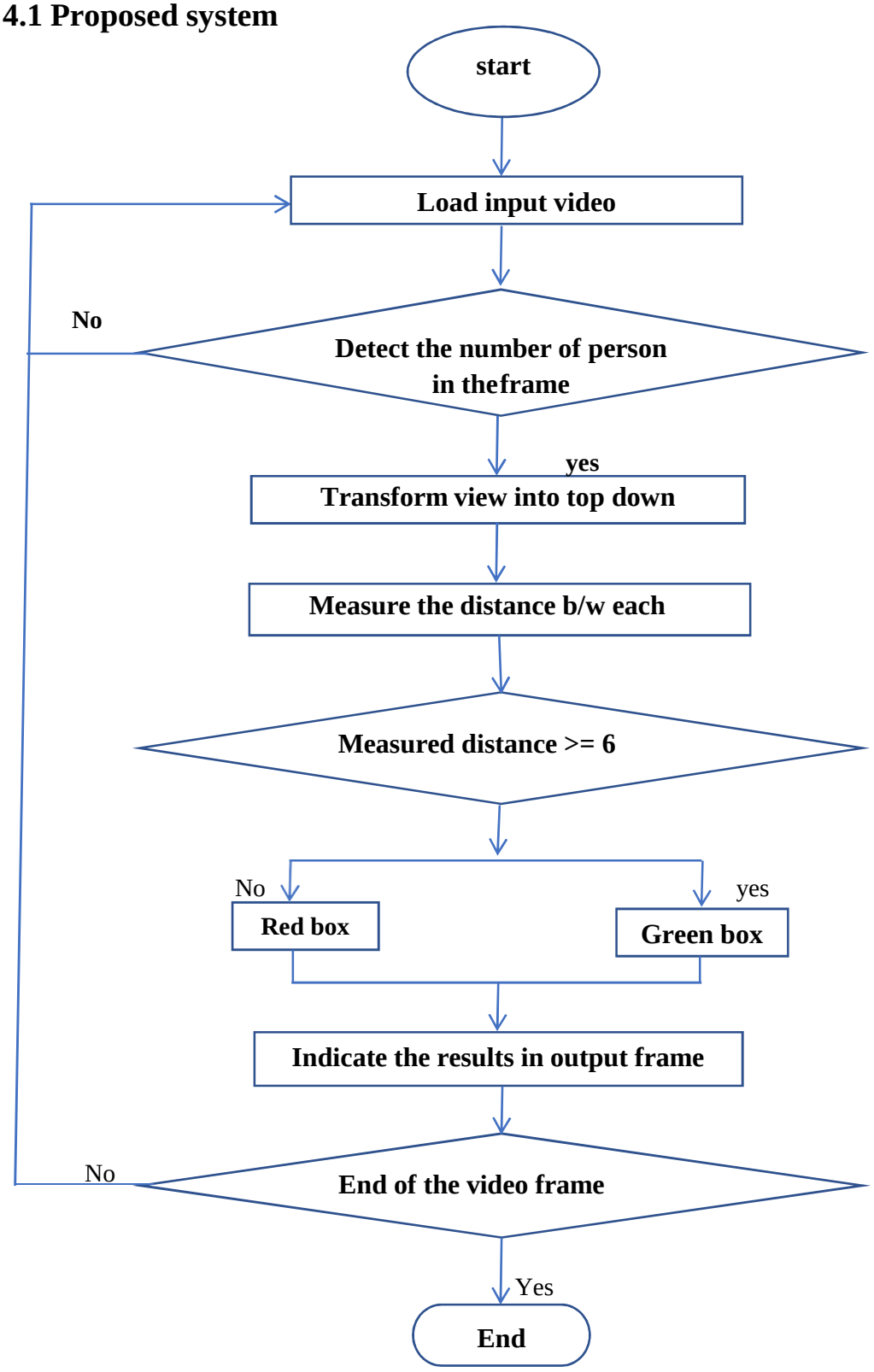


Figure 4.1: Flow chart

- The proposed system helps to ensure the safety of the people at public places by automatically monitoring them whether they maintain a safe social distance, how the proposed system will automatically functions in an automatic manner to prevent the coronavirus spread.
- The proposed system uses a transfer learning approach to performance optimization witha deep learning algorithm and a computer vision to automatically monitor people in public places with a camera integrated with a raspberry pi4 and to detect people withmask or no mask. We also do fine tuning, which is another form of transfer learning,more powerful than just the feature extraction.
- The proposed system focuses on how to identify the person on image/video stream whether the social distancing is maintained or not with the help of computer vision and deep learning algorithm by using the Open CV, and single shot object detection(SSD)[14].
- This section discusses the essential steps which are attempted to establish a workflow for monitoring social distancing on thermal as seen .
- Prepare the thermal images or streaming a video from a thermal camera which contains people.
- Applying the deep learning object detector to detect people in thermal images or video streams.
- Check the number of persons that are in the images or video stream.
- Compute the distance between the centroid of the bounding boxes which are enclosed to the detected people.
- Finally, the algorithm will decide for safe or unsafe social distancing based on the number of persons and the measured distance between the centroid of boundaries boxes.

4.2 SOFTWARE REQUIREMENTS:

1 Anaconda 3(64 bit software)

Anaconda: Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing that aims to simplify package management and deployment. Package versions are managed by the package management system conda. The Anaconda distribution includes data-science packages suitable for Windows, Linux, and macOS[15].

Anaconda distribution comes with 1,500 packages selected from PyPI as well as theconda package and virtual environment manager. It also includes a GUI, Anaconda Navigator,as agraphical alternative to the command-line interface (CLI).

Python 3 - We have used Python which is a statistical mathematical programming language like R instead of MATLAB due to the following reasons:

Figure 4.2: Python symbol

1. Python code is more compact and readable than MATLAB.

2. The python data structure is superior to MATLAB

3. It is an open source and also provides more graphic packages and data sets

Keras (with TensorFlow backend 2.3.0 version) - Keras is a neural network API consisting of TensorFlow, CNTK. Theano etc.

Python packages like Numpy, Matplotlib, Pandas for mathematical computation and plotting graphs, Simple ITK for reading the images which were in .mha format and Mahotas for feature extraction of GLCM Kaggle was used to obtain the online dataset. GitHub and Stack overflow was used for reference in case of programming syntax errors. Officially launched in 1999 the OpenCV project was initially an Intel Research initiative to advance CPU-intensive applications, part of a series of projects including real-time ray tracing and3D Display walls. The main contributors to the project included a number of optimization expert in Intel Russia, as well as Intel's Performance Library Team. In the early days ofOpenCV, the goals of the project were described as:

- Advance vision research by providing not only open but also optimized code for basicvision infrastructure. No more reinventing the wheel.
- Disseminate vision knowledge by providing a common infrastructure that developers could build on, so that code would be more readily readable and

transferable.

- Advance vision-based commercial applications by making portable, performance optimized code available for free – with a license that did not require code to be openor free itself.

He first alpha version of OpenCV was released to the public at the IEEE Conference on Computer Vision and Pattern Recognition in 2000, and five betas were released between 2001 and 2005. The first 1.0 version was released in 2006. A version 1.1 & was released in October 2008.The second major release of the OpenCV was in October 2009. OpenCV 2includes major changes to the C++ interface, aiming at easier, more type-safe patterns, new functions, and better implementations for existing ones in terms of performance (especially on multi-core systems). Official releases now occur every six months and development is now done by an independent Russian team supported by commercial corporations. August 2012, support for OpenCV was taken over by a non-profit foundationOpenCV.org, which maintains a developer and user site. On May 2016, Intel signed an agreement to acquire Its sees, a leading developer of OpenCV.

In July 2020, OpenCV announced and began a Kick starter campaign for the OpenCV AI Kit, a series of hardware modules and additions to OpenCV supporting Spatial AI.

Spyder 5.1.5

Spyder is a powerful scientific environment written in Python, for Python, and designed by and for scientists, engineers and data analysts. It features a unique combination of the advanced editing, analysis, debugging and profiling functionality of a comprehensive development tool with the data exploration, interactive execution, deep inspection and beautiful visualization capabilities of a scientific package.

Figure 4.3: Spyder symbol

Furthermore, Spyder offers built-in integration with many popular scientific packages, including NumPy, SciPy, Pandas, IPython, QtConsole, Matplotlib, SymPy, and more. Beyond its many built-in features, Spyder can be extended even further via third-party plugins. Spyder can also be used as a PyQt5 extension library, allowing you to build upon its functionality and embed its components, such as the interactive console or advanced editor, in your own software.

Operating system: Windows

Technology: Computer Vision,

Python Packages: Open-cv, Numpy , Argparse

4.3 HARDWARE:

OS-windows

Processor-i5

Systemtype-64bit Processor-i.

4.4 BLOCK DIAGRAM

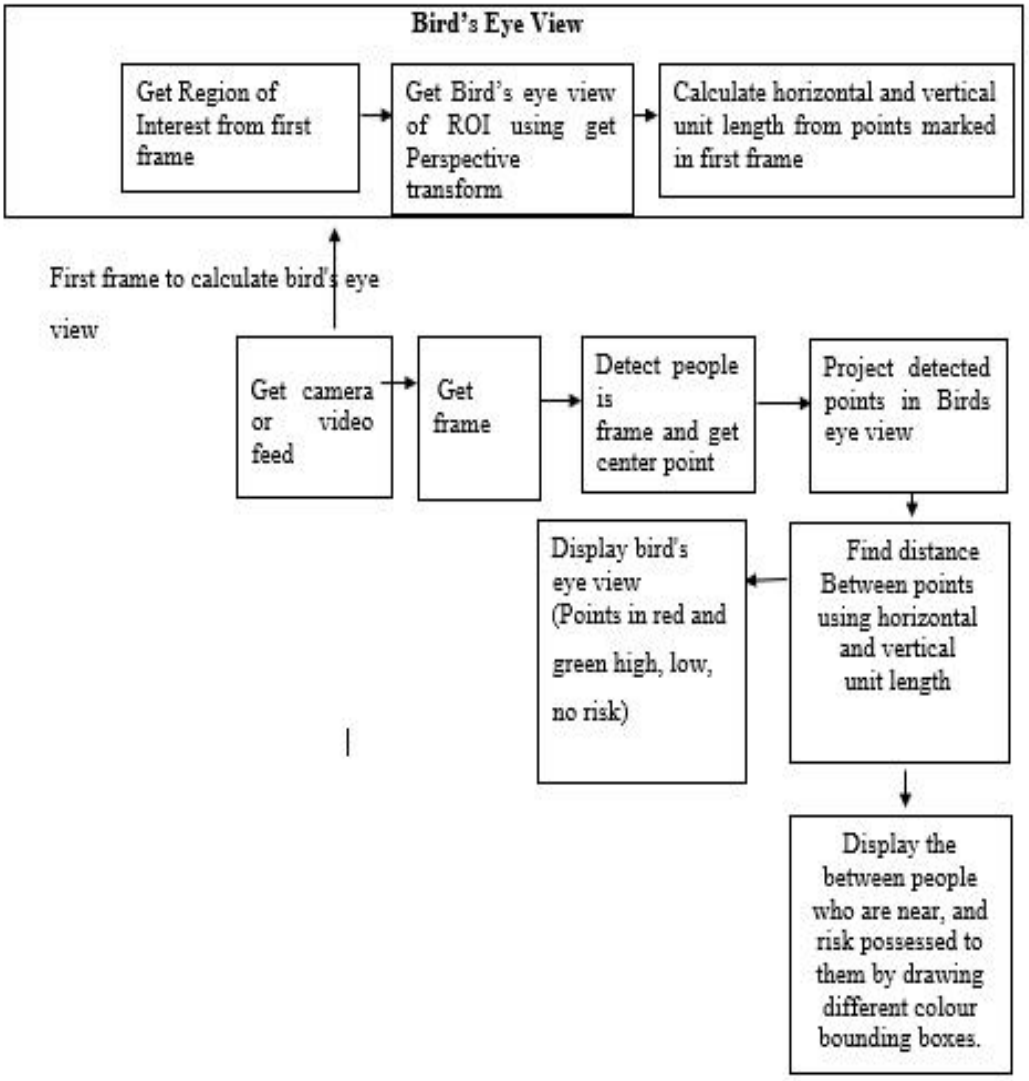


Figure 4.4: Block Diagram

The image how we can select a Region of Interest (ROI) and this is a one - time step. We draw 8 points on the first frame using a mouse click event. The first four points will define ROI where we want to monitor social distancing. The next 3 points will define 180 cm(unit length) distance in horizontal and vertical directions and those should form parallel lines with ROI. In the above image we can see points 5 and point 6 define 180 cm in real life in the horizontal direction and point 5 and point 7 define 180 cm in real life in the vertical direction. As we can see ROI formed by the first 4 points. distance horizontal and vertical direction, so the number of pixels in 180 cm for horizontal and vertical

direction will be different in rectangle (bird's eye view) formed after transformation. So, from points 5, 6, 7, we are calculating scale factor in the horizontal and vertical direction of the bird's eye view, e.g. how many pixels correspond to 180 cm in real life.

A bounding box will be displayed around every person detected. Although SSD is capable of detecting multiple objects in a frame, it is limited to the detection of a single person in this system. To calculate the distance between two persons first the distance of person from camera is calculated using triangle similarity technique, we calculate perceived focal length of camera, we assumed person distance D from camera and person's actual height H=165cms and with SSD person detection pixel height P of the person is identified using the bounding box coordinates. Using these values, the focal length of the camera can be calculated using the formula below

$$F = (P \times D) / H$$

Then we use the real person's height H, the person's pixel height P, and the camera's focal length F to measure the person's distance from the camera. The distance from the camera can be determined using the following:

$$D1 = (H \times F) / P$$

After calculating the depth of the person in the camera, we calculate the distance between two people in the video. A number of people can be detected in a video. Thus, the Euclidean distance is measured between the mid-point of the bounding boxes of all detected individuals. By doing this, we got x and y values, and these pixel values are converted into centimeters. We have the x, y and z (the person's distance from the camera) coordinates for each person in cms. The Euclidean distance between each person detected is calculated using (x, y, z) coordinates. If the distance between two people is less than 2 meters or 200 centimetres, a red bounding box is shown around them, indicating that they do not maintain a social distance. In the proposed system transfer learning is used on top of the high performing pre-trained SSD model for face detection with mobileNet.

The result of the SSD model extracts a person and displays a bounding box. This system can be used in real-time applications requiring a secure monitoring of social distance between people and the detection of social distances for safety purposes due to the outbreak of Covid-19. This system can be integrated with edge device for use in airports, railway stations, offices, schools and public places to ensure that public safety guidelines

are followed.

People detection: The objective is to develop a model to detect humans (people) With various Types of challenges such as variation sin clothes, close distances, with/without occlusion, and under different lighting condition. Modern DNN-based detectors consists of two sections: A backbone for extracting features and a head for predicting classes and location of objects. The responsible of DNN for the classifying the objects as well as calculating the size of the objects and the coordinated of the correspondent bounding boxes. There are usually two types of head sections: one stage and two-stage. The two stage detectors use the region proposal before applying the classification. First the detector extractsa set of object proposals(candidate bounding boxes) by a elective search. Then it resizes them to fixed size before feeding them to the DNN model. The two-stage detectors use the region proposal before applying the classification. The on-stage detectors perform a single detection. "Single shot detection object detection (SSD)". Such detectors use regression analysis to calculate the dimensions of bounding box e sand interpret their class probabilities.

Euclidean distance over a detected boundary box

Once a centroid is determined from a set of fixed boundary boxes. calculates Euclidean distance over determined boundary box along with point.

It is calculated by using the formula

$$\mathrm{d}(\mathrm{x},\mathrm{y}) = \sqrt{\sum_{i=0}^{n}(yi - xi)^2}$$

Step 1: Accepting the bounding boxes and computing the corresponding centroids which means the center of bounding boxes.

Step 2: Computing Euclidean distance between new centroids (yellow) represented by x,y, z and old centroids (brown) represented by a, b. • Centroid tracking works on an assumption that the pair of centroids with minimum Euclidean distance or the closest pair is must be the same person. So, unique ID will be generated to that pair i.e., person. • In the above image there are two existing centroids and three new centroids from the previous frame which describes a new person has been detected in this frame.

Step 3: Association of ID's as we know Euclidean distances.

Step 4: New ID's will be registered by storing co-ordinates of bounding boxes of new object i.e., person.

Step 5: The object which leaves our frame area then we will just deregister the object.

Step6: Distance computation using Euclidean distance as metric Computation of distance between the pairs of detected persons using Euclidean distance as metric.

Centroid over an image

Once boundary box is detected over an image, Next centroid is automatically calculated over an image. That paves the way to get the canter position of all the boundary boxes. After getting canter position of all the boundary boxes, then we apply Euclidean distance, over every box along with centroid point. Finally, if the values are less than our fixed threshold value, there exists a violation.

In general, for instance it works between each and every detected boundary boxes. Initially select any one boundary box out of an image, then applying the above equation is to find out centre position of an image.

In this process camera video feeds from the Network Video Recorder (NVR) are streamed using RTSP and then these frames are converted to grayscale to improve speed and accuracy and are send to the model for further processing inside raspberry pi4. We have used the MobileNetV2 architecture as the core model for detection as MobileNetV2 provides a huge cost advantage compared to the normal 2D CNN model. The process also involves the SSD MultiBox Detector, a neural network architecture that has already been trained on a large collection of images such as ImageNet and PascalVOC for high quality image classification. We are loading the MobileNet V2 with pre-trained ImageNet weights, leaving the network head off and constructing a new FC head, attaching it to the base instead of the old head, and freezing the base layers of the network. The weights of these base layers will not be changed during the fine-tuning phase of the back propagation,while the head layer weights will be adjusted. After data is prepared and the model architecture is set up for fine tuning, then the model is compiled and trained. A very smalllearning rate is used during the retraining of the architecture to ensure that the convolutional filters already learned do not deviate dramatically and experiments have been carried out with OpenCV, TensorFlow using Deep Learning and Computer Vision in order to inspect the safe social distance between detected persons and face masks

detection in real-time video streams. The main contribution of the proposed system is three components: person detection, safe distance measurement between detected persons, face mask detection. Real-time person detection is done with the help of Single Shot object Detection (SSD) using MobileNet V2 and OpenCV, achieves 91.2% mAP, outperforming the comparable state of-the-art Faster DNN model.

They will be highlighted with red color bounding boxes and the number of violations at that particular frame will be displayed. The persons who are maintaining more than M pixels of distance will be considered as non-violation pair and they will be highlighted with green color bounding boxes.

Step involved finding out social distance among people. Once an objects are detected by means of improved SSD, that information is treated as boundary box information. Also, a centroid is determined over every detected boundary box. Then find out meanwhile distance among each determined centroid over an image, a Euclidean distance is used. A threshold predefined value is equal to 6 ft is employed to verify that the distance between any two-boundary centroid is less than the number of pixels configured. If two persons are very close in contact means violation exists, that is, the distance between each of them is much shorter than the distance we specified [i.e., threshold]. Then that particular information is kept and stored as violation set. Because there is a violation, that particular boundary box color will be change to red. To determine those people who violate social distancing, a centroid chasing algorithm is used .and the final output will be our model produce the total number of people who violets social distance along with its detected boundary boxes and centroid Boundary boxes. The conclusion derived from literature survey point out that, if we want to detect every object individually from the set the objectover the image, the concept of boundary boxes is used these boxes are covered indifferent spatial locations (for each filter) with different size or different sizes or dimention and proportions in the input image. In our work, we used width [W] x height [H] to generate boundary boxes over the dimensions on image.

Consider any location of dimensions of image can be wp$\sqrt{r}\bar{X}$ $Hp\sqrt{r}$. the ratio of aspect is r>0 also the parameter is ‘p’ which ranges from (0, 1). For each model from literature, alsoour model enhanced SSD, are used the configured value of P and r which is given . Then trained process is done over detection model in order to predict and determine whichclass, the generated Boundary box is belonging to.

Also any Adjustment is required on the boundary box dimensions [adjust height and width], we have establish a balancer to take care of it, also that enables to fit the ground truth object in a better way and paves the way to reduce the loss regression and classification. But in a real work environment, usually objects are closely in nature and kept in close contact with each other, so possibility of getting overlapping in the boundary boxes. So, we used non-max suppression (NMS), to determine the IOU[intersection over union] boundary. That helps to retrieve our of interest [individual persons] effectively. Then determine overlapping region ratio between ground truth value and the predefined boundary box. Finally the determined score value is compared with hyper -parameter of fixed threshold and the image of best boundary box is returned.

CHAPTER 5

RESULTS & DISCUSSION

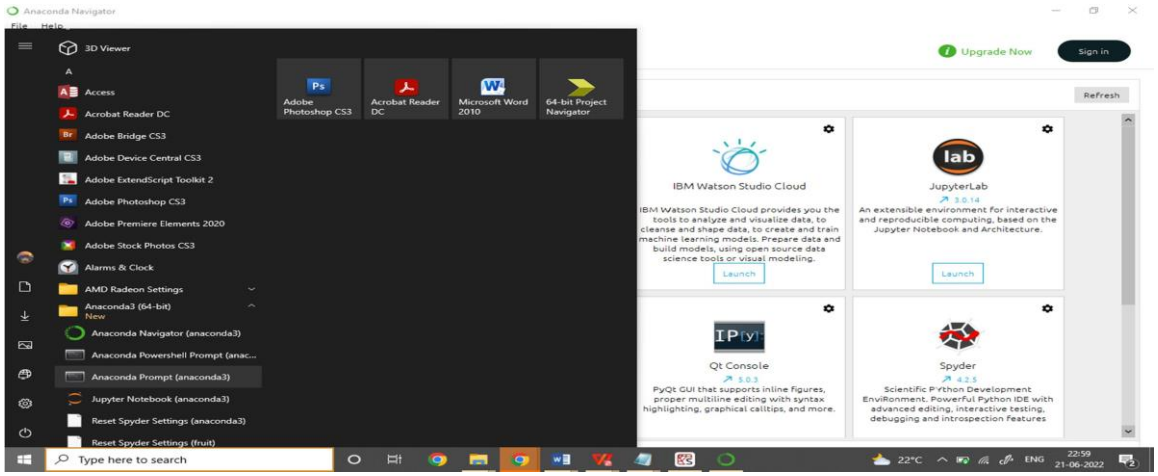
5.1 SimulatioResults

Steps to run a program

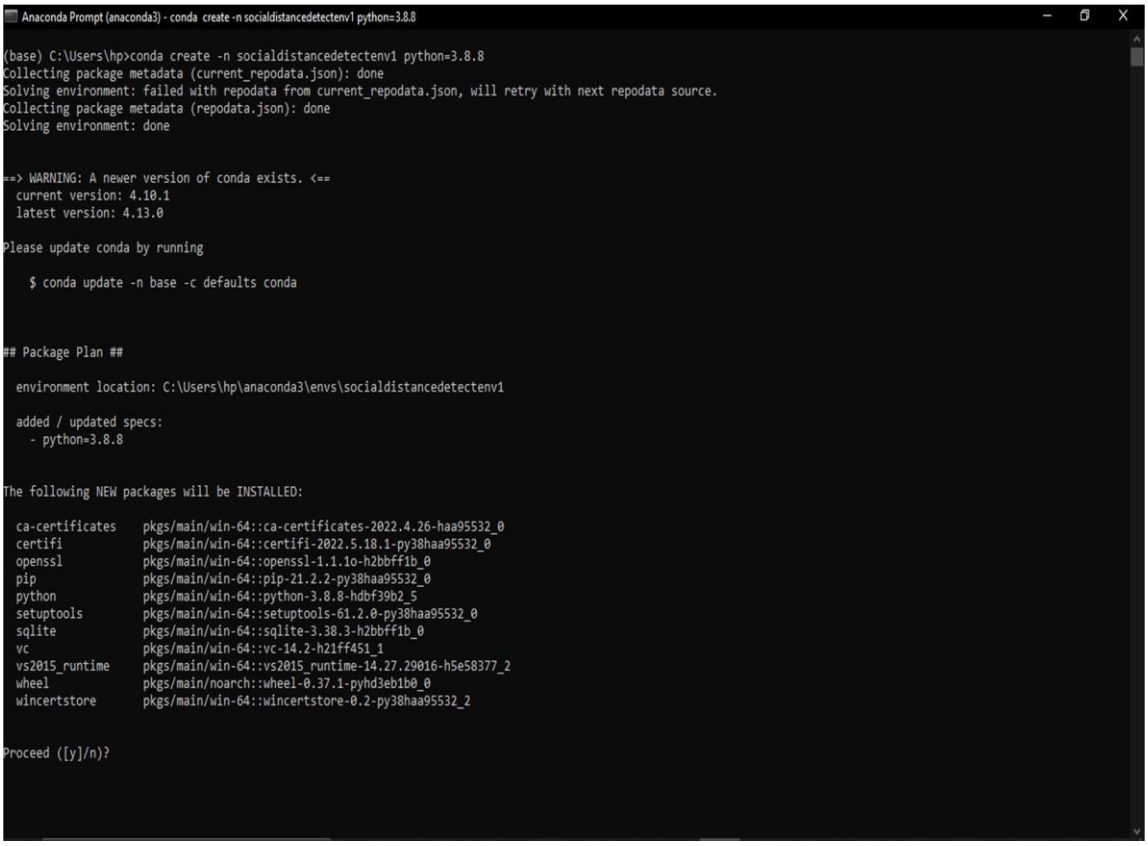
Following are the results generated after creating the social distancing detection model and testing the model on two sample input videos as well as on a real time input. The green bounding boxes around people indicate that those people are not violating the social distancing rules while the red bounding boxes indicate otherwise. The total number of social distancing violations are displayed at the bottom left of the screen.

Step 1: Go to start button open the anaconda Navigater.

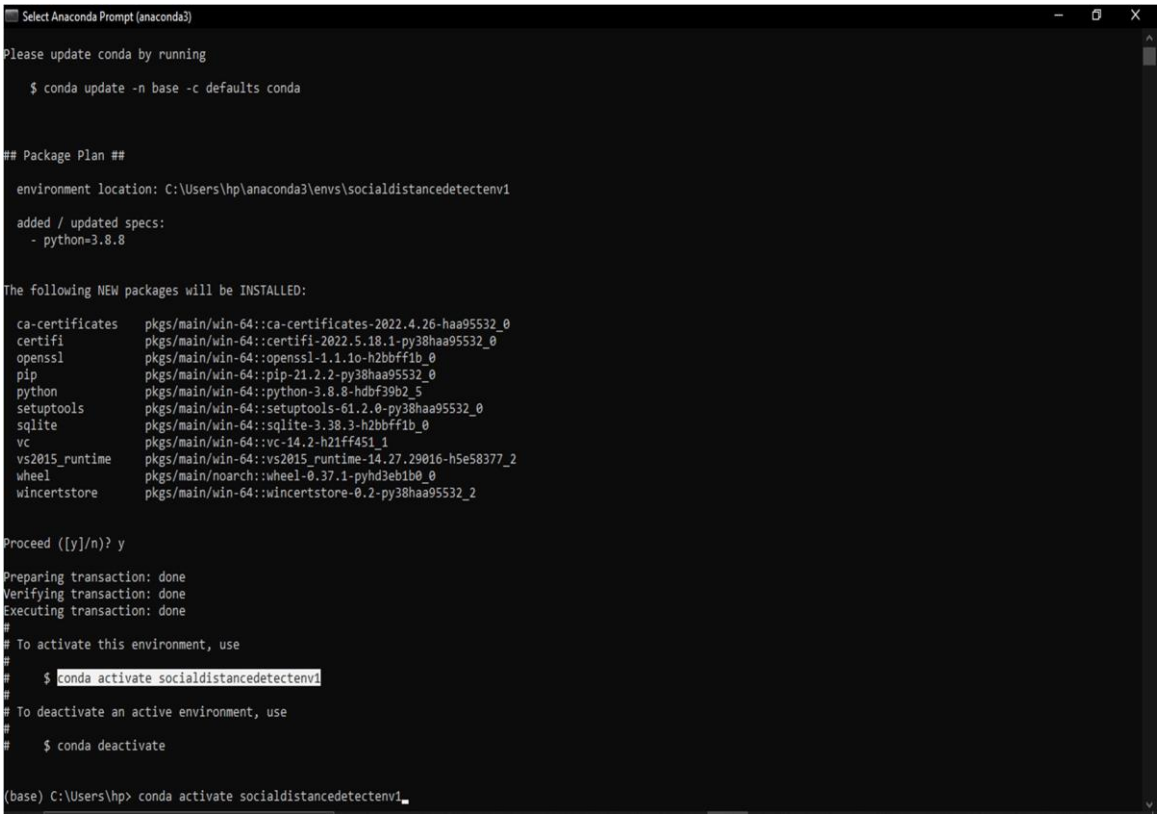
Step 2: select Anaconda promt



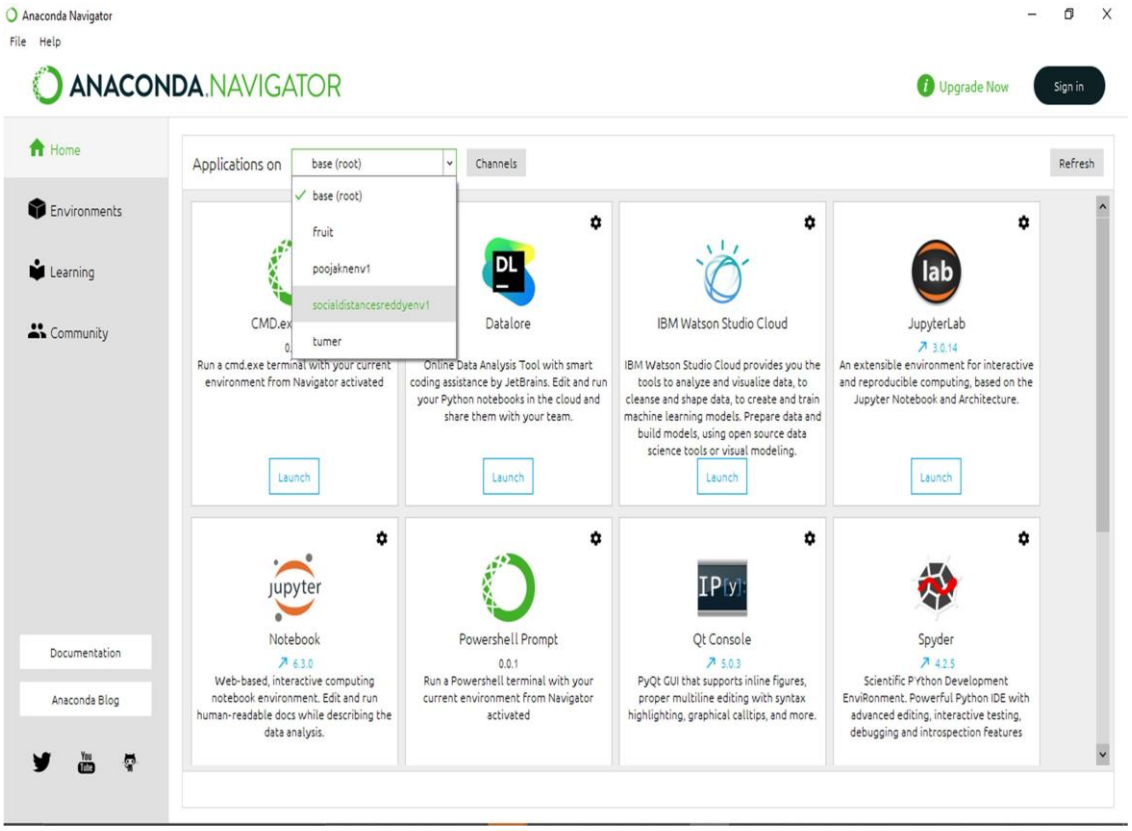
Step3: After opening Anaconda navigater we create the Base environment



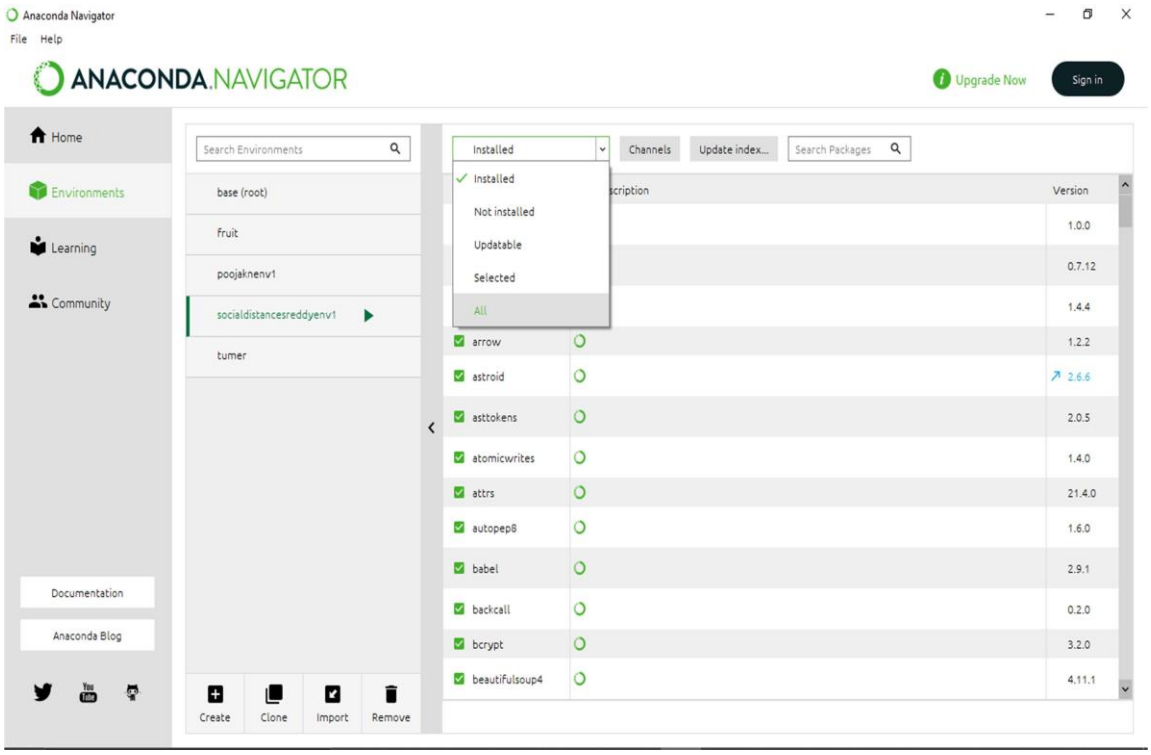
Step 4: After creating base environment then activate our creating environment



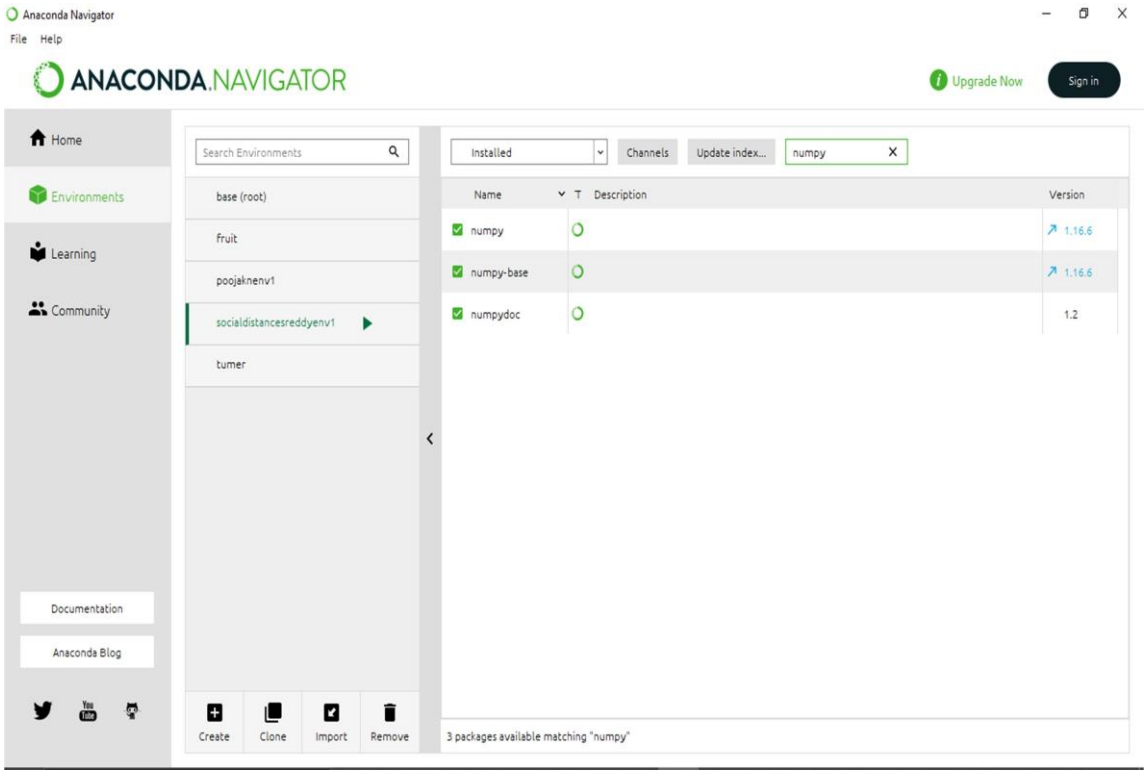
Step 5: Here we chose the home, then go to application & select our environment.



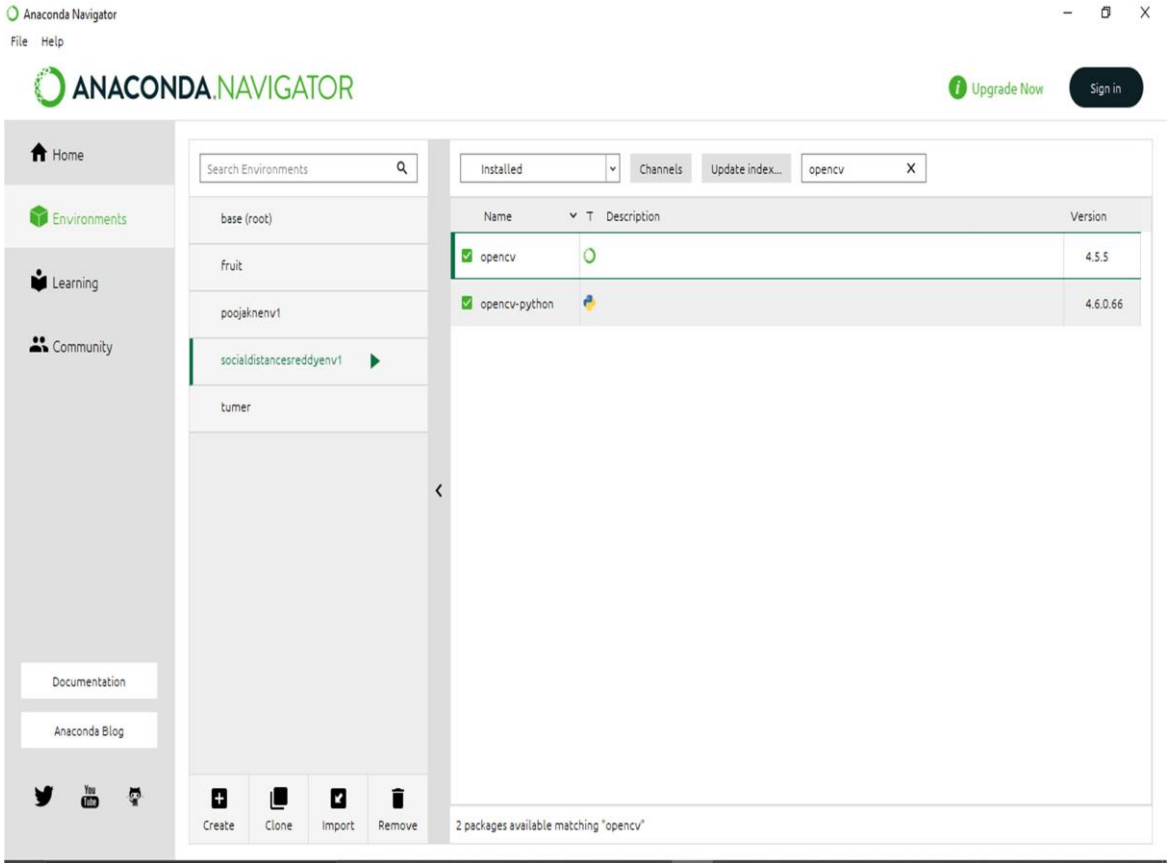
Step 6: After selecting environment then we install all python packages required to our project.



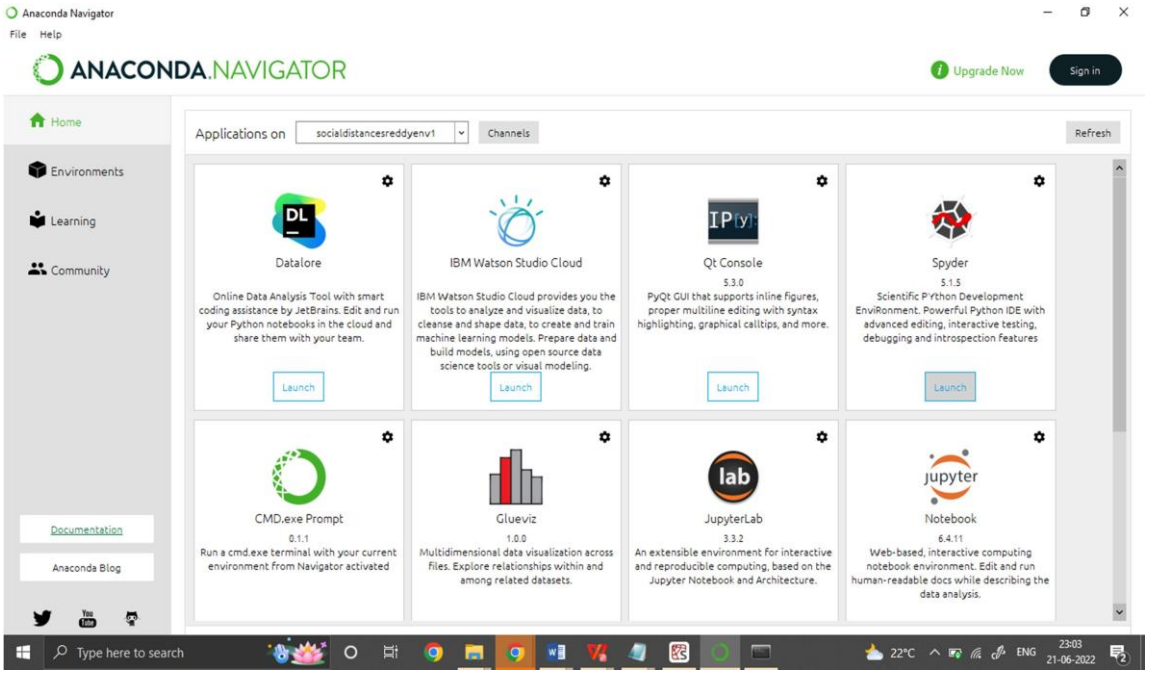
Step 7: Installing the Numpy library



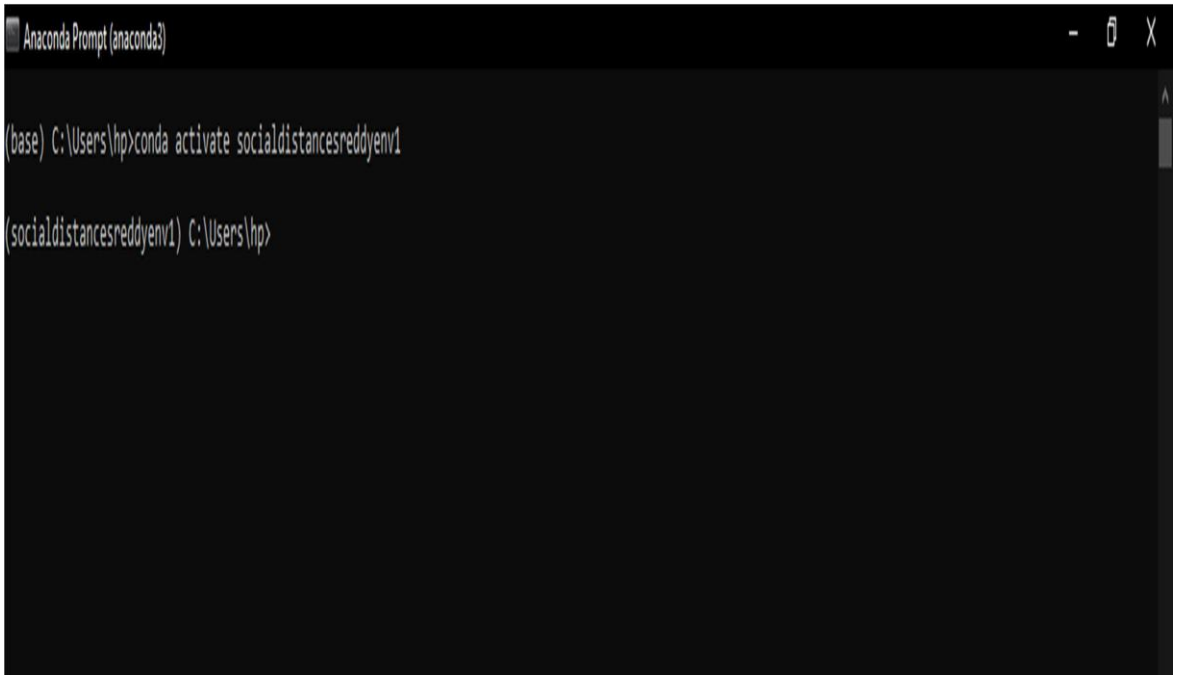
Step 8: Installing the open-cv & Argparse



Step 9: After installing the all libraries then Install spyder software.

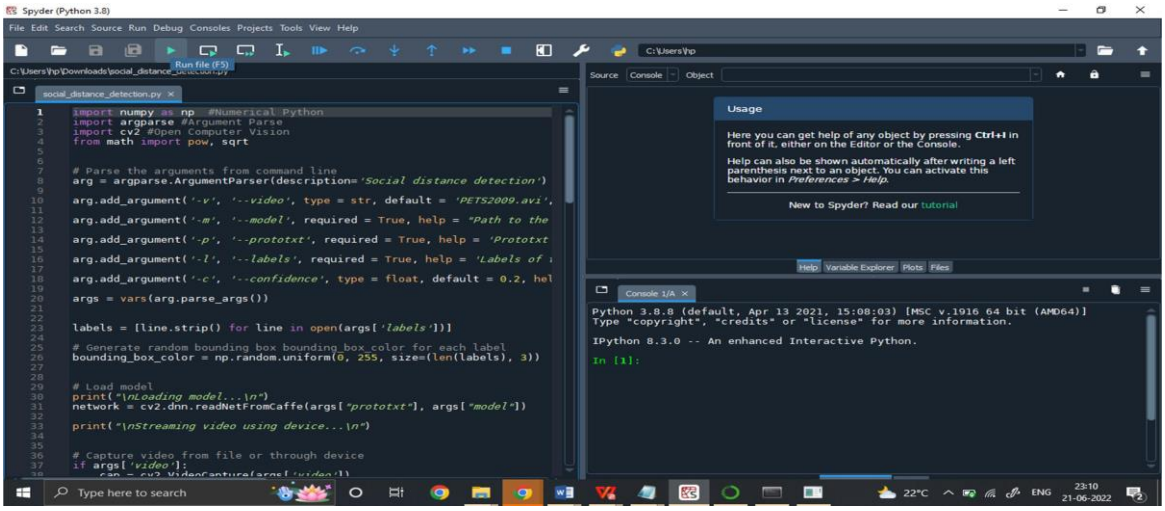


Step 10: Then go back to anacond promt and give the location/path along with cd command.

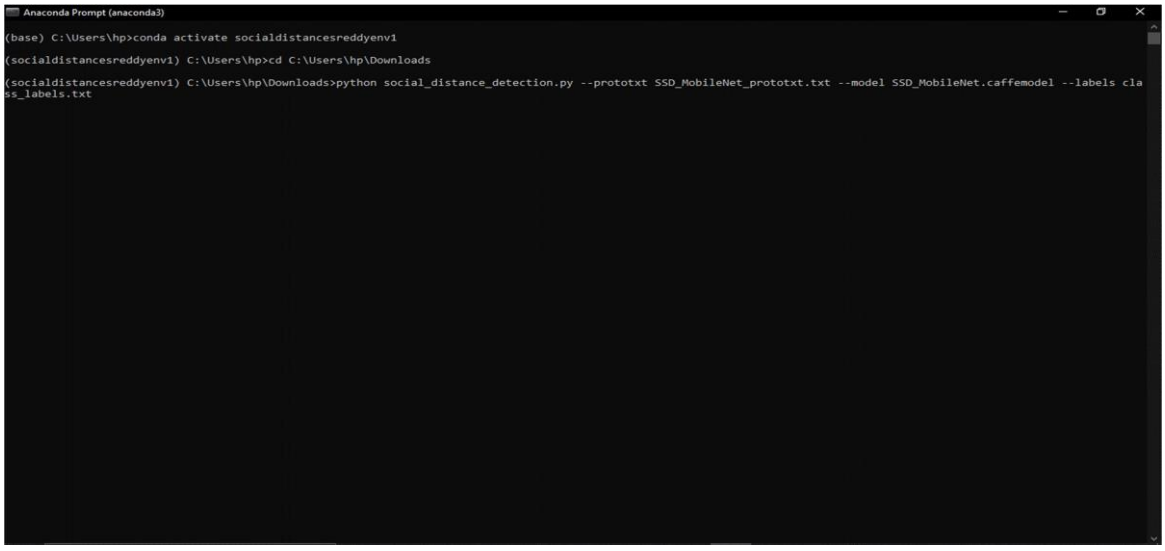


Step 11: Before we run the project just we launch the spyder 5.5 software.

Step 12: After launching spyder software we run the code/program.

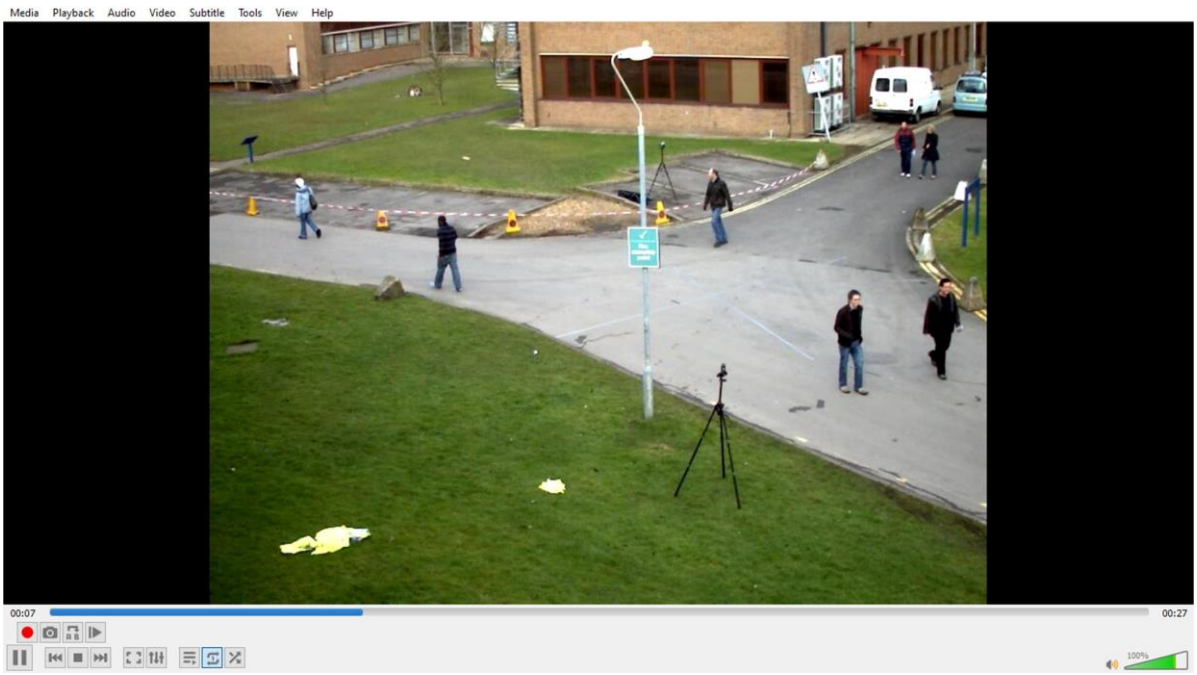


Step 13: Here give the command as , python social_distance_detection.py –prototxt SSD_MobileNet_prototxt.txt --model SSD_MobileNet.caffemodel --labelsclass_labels.txt.



Step 14: This is the input video given as the names as PETS2009.avi.

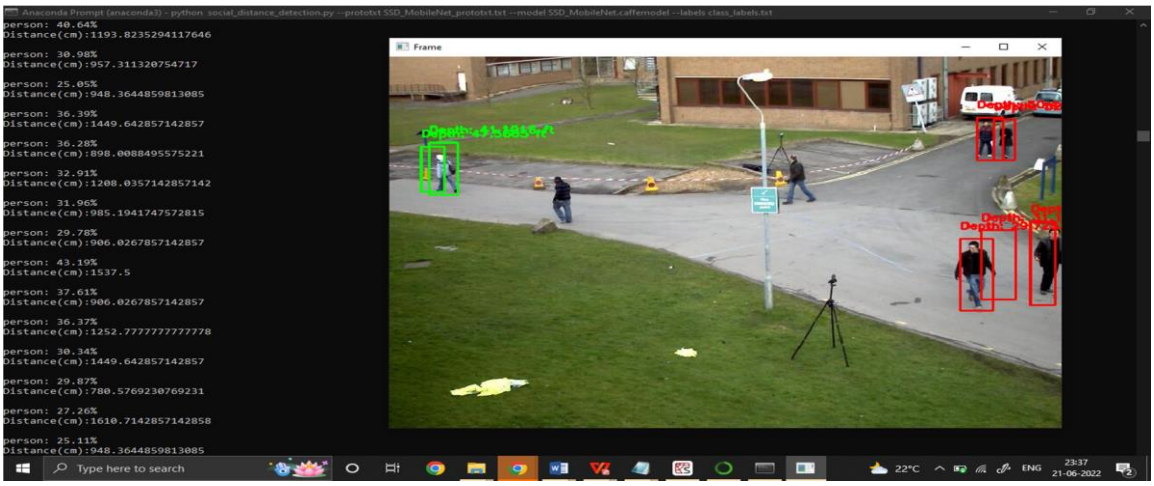
Captured image and video recorded by CCTV camera are provided as input as shown in Image 4. The camera is set to a predictable angle and the video frame view was changed. in a 2D bird view to accurately measure the distance between each individual. It is assumed that people inside the frame they are measured in a horizontal plane. Then, four points from the horizontal plane are selected, and then converted into a bird's view. Now the position of the individual can be calculated based on in bird view.

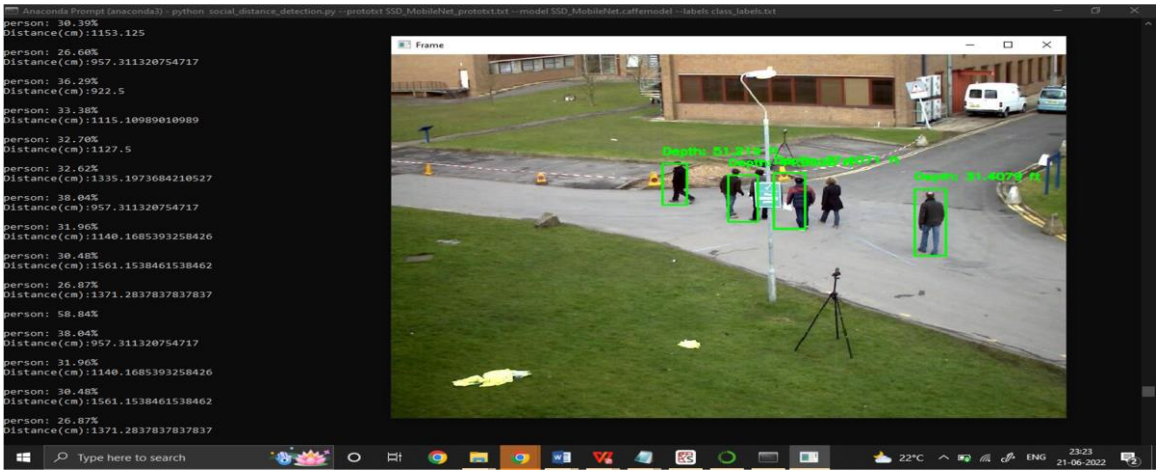


Interval between people is easily measured, measured, and measured by count Euclidean distance between centroids. Limit value or minimum fixed distance value is set. Depending on the amount, any distance below the minimum value is available, then a warning is displayed using red-coloured binding boxes.

Step 15: After given input then Run, this is the output.

The interval between individual sets in the input frame can be easily calculated and combined the individual box is mapped. To do so in the middle of a map box with everyone inside width is considered. Figure represents the steps followed by the community distance analysis model to calculate distance and create A set of people whose interval is less than the minimum set threshold value is considered violation. People who violate the condition are marked using a red box, and the rest of the people tagged using a green box.





5.1 ADVANTAGES:

- Reassuring Employees 41% of employees not wanting to return to the office until the workplace is safe. having social distance detection in the workplace has been made as for their benefit.

- **Utilizing space**: Using the detection software you will have the ability to see which areas are the most dangerous. you will take care of your relevant safety measure sat that places.

- **Monitoring & Measuring**: The software can be used to monitor the working environment and highlight people whose distancing is below the minimum acceptable distance.

5.2 DISADVANTAGES

- Camera calibration.

5.3 APPLICATIONS

- Colleges and universities
- Non-essential workplaces
- Malls
- Individuals limit face-to-face contacts
- Individuals avoid public places

5.4 FUTURE SCOPE

- Can be used to alert individuals by notifying them, after face recognition.
- In large areas, can be used to identify which spots have higher concentration of people which could lead to no social-distance.
- Can be used to keep track of the number of times an individual doesn't maintain social distance.
- Since SSD also detects many objects other than people, this project can be used to find the distance between cars, bikes, etc. Finding the distance between objects like cars, can help in alerting if a car is about to touch another car or a tree, etc.

CHAPTER 6

CONCLUSION

This study shows that SSD object detection algorithm has the advantages of high accuracy and speed in the application of social distancing monitoring in public places. People are often relatively small in surveillance video, which is just good for taking advantage of SSD detection of small objects. This will help to ease the spread of the epidemic. This study uses the original SSD model, if the model architecture is modified and optimized, the recognition accuracy of small objects will be further improved. In addition, the model can be deployed on a high-performance GPU to further improve the detection frame rate and real-time performance.

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