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Award name: BSc (Hons) Computing

Module code: 14806

Module name: Production Project

Module run: 2022

Coursework title: Smart Covid Violation Detector

Due Date: 5th June 2022

Module leader: (In LBU) Mr. Rohit Raj Pandey

Module Supervisor: (In TBC) Mr. Suramya Sharma Dahal

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Abstract:

With the rapidly increasing development of AI and IoT, a growing number of AI systems and machines are interconnected with each other. Each day researchers are finding new technologies that are so related and important to living creatures, mostly humans. The advent of Artificial intelligence makes it so easy. With the utilization of AI and IoT, new opportunities are discovered for making life easier and more efficient. Smart COVID Violation is one such system inspected by the AI that helps prevent human life from the different dangerous viruses which are harmful to humans by detecting face masks, social distance as well as number plates of the vehicle in the crowded places and areas and detecting if any of them are violating the rule, the system will notify them with a notification alert. This report is focused on the implementation of the Smart COVID Violation Detection choosing to focus on virtual surveillance and controlling different perspectives such as object detection, movement detection, notification alert system, and so on. Furthermore, the technology aims to guide people in automating daily actions such as alerting them when they do not wear masks or if they violate the social distancing rule by identifying their presence in public areas. The end product was productive and convenient as expected.

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Student Declaration

I hereby declare that in 2022, under the direction of Mr. Suramya Sharma Dahal, Project Supervisor at The British College, I handed in my project, which was titled "Smart COVID Violation Detector," in order to partially satisfy the requirements for the BSc (Hons) Computer Science degree that were established by the college.

I also declare that this research project is the result of my own hard work and that it has not been submitted to any other university for the purpose of getting a degree in any subject.

Table of Contents

Acknowledgment

A special word of thanks goes out to the people who helped me get this opportunity to work on this worthwhile project concerning Smart COVID Violation Detector under the guidance of Mr. Suramya Sharma Dahal and the Module Leader Rohit Raj Pandey. They have my deepest gratitude.

CHAPTER 1

1. INTRODUCTION

During the pandemic, there was no evidence to support the utilization of public masks to limit the transmission of lung infection. So the masks are designed to keep people from transmitting virus particles. Face masks are suggested as a part of private safety equipment and as part of a personal health strategy to prevent the spread of infection. For this, the creation of a system capable to detect people that wear masks is crucial in today's environment. To implement the use of wearing face masks in crowded areas, the researchers attempted to construct a face mask recognition system in public locations. Surveillance systems are used to monitor public spaces with the use of an image processing algorithm, ensuring that no one's face is visible without a facial mask in busy areas. (face-mask-detection, 2022)

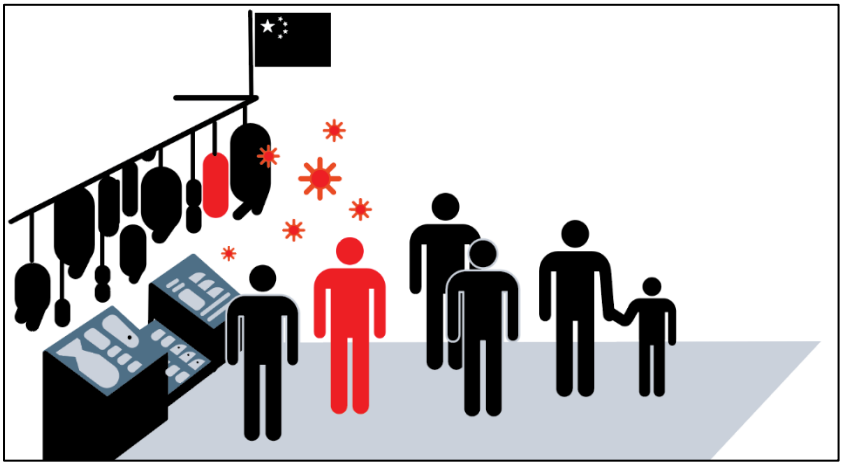

Figure 1. Showing how Coronavirus is spreading within an organization

As we know, a social distance between the people overcomes the virus's spread by reducing human-to-human contact. To determine social distancing among the

people, a machine learning-based framework is utilized. Similarly, to control the spread of the virus odd-even number traffic control rule and estimate the social distancing rule between people in public places are also implemented. To detect the odd-even number plate detection virtually, an automated vehicle number plate detection is created using artificial intelligence and machine learning. So that, traffic can ensure the vehicle number plate and detect the vehicle that violates the rule.

Government and global health officials are exploring new ways to reduce the spread of COVID. Every day, healthcare professionals and scientists are exploring to control the COVID-19 spread. As we know the fact that using a face mask, maintaining social distancing, and making the odd-even rule on the vehicle are beneficial. In this pandemic situation, it is not possible to check whether the person who is entering an organization is wearing a mask or not and maintained social distancing or not physically. So, Smart Covid Rule Violation Detector is made which makes our lives easier and prevents life from spreading Covid by detecting facial masks using open cv and pre-trained models, evaluating the social distancing of people, and detecting the embossed odd-even number plate. This facility use principles such as face detection, object detection, and picture processing, among others. (“Face Mask Detection System using AI | AI Mask Detection”, 2022)

1.1 Project Aim

The project’s goal is to develop a software-based product to detect COVID regulations violations. The final result is primarily dependent on several elements such as face mask detections, maintaining a social distancing, and an identification system of the automatic number plate of vehicles produced using the machine-learning algorithm. This method aims to reduce the COVID spread in large groups by utilizing a variety of analyzing tools.

1.2 Objectives

The objectives of the project are as follows;

1. Using OpenCV and a pre-trained model, detect the mask on the face.
2. Using a camera module, determine whether the vehicle's license number plate is an odd or an even number.
3. Calculating the social distance in a line can be applied in shopping malls, hospitals, and so on.
4. Face detection, object detection, image processing, and other ideas are employed.

1.3 Statement of Problem

During the project, the process of choosing an appropriate pre-trained object detection model and developing it in this project was difficult. To complete this project, datasets are collected from the open-source and trained in the model to detect the face mask detection. Since the accuracy of the detection varies from product to product, the process of the object detection model is trained with the various processing speed which is one of the toughest tasks to complete. Similarly, to train the model for social distancing and the number plate detection, suitable AI models are chosen. The goal of this research is to illustrate currently available pre-trained object identification models.

1.4 Scope and Limitations

We were instructed to wear masks at all times and to arrange our cars in odd and even numbers in order to minimize our exposure to the virus. " Smart COVID Violation Detection, on the other hand, uses face mask detection to assess whether or not a person is wearing a mask". Similar to this, Python and machine learning are used to determine whether or not a vehicle's license plate is odd or even. Artificial intelligence (AI) is used in machine learning, which is a type of data analysis. We used object detection to identify odd-even number plates on

automobiles and a social distancing analyzer based on machine learning in this investigation.

1.5 Structure of the Report

This report begins with a short introduction to IoT, Artificial intelligence, machine learning, OpenCV, TensorFlow, and other frameworks which are utilized to complete this project. Where it describes the advantages that are so much important in human life, especially in the ongoing pandemic. After that, the literature review of face mask detection, social distance estimation, and automatic number plate detection, as well as the technologies that are used in this project that is both software and hardware, are described. Then, to go through the project, the chosen methodology is described then the requirement of the specification of the project is described. Similarly, “the end product’s conceptual and logical diagrams are described by its execution and testing phase. The evaluation of the overall product, as well as the project, is described”. Finally, All the tasks completed during the project are concluded with a summary.

CHAPTER 2

2. LITERATURE REVIEW

2.1 Internet of Things

The Internet of Things (IoT) is a network system of computer equipment, machines, and digital machines, objects, and people that allows data to be exchanged without the use of unique identifiers and between people or between people to computer communication. Things on the Internet of Things include people with implanted heart rate monitors, livestock with implanted biosensor transponders, built-in sensors that warn drivers when tire pressure is low, or other natural or artificial objects. Organizations of all types are increasingly relying on various technologies to improve customer service, make better decisions, increase operational efficiency, and obtain a better understanding of their consumers.

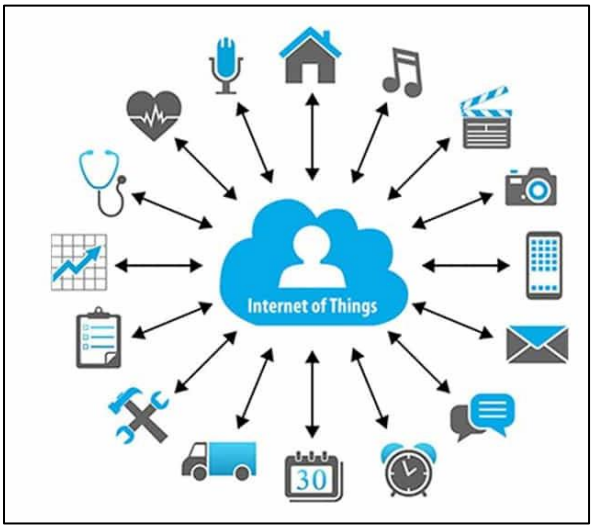

Figure 2. Showing the Internet of Things

The Internet of Things is made up of internet-connected smart machines that use intelligent systems such as CPUs, communication, sensors, and equipment to

collect, send, and act on information from that environment. IoT systems exchange sensor information with a network or another edge device, which is then transferred to the cloud for processing or inspection locally. These devices may interact with each other and rely on data received on occasion. Although humans could engage with this type of machine to set them up, provide instruction, or obtain information, the machines conduct the majority of the work. (What is IoT (Internet of Things) and How Does it Work? - Definition from TechTarget.com, 2022)

2.2 Smart COVID Violation Detector and Its advantages

With its devastating spread, the continuing COVID-19 coronavirus pandemic has caused a global calamity. The lack of effective antiviral treatments and vaccines makes the population more vulnerable. Social isolation is considered appropriate protection against the transmission of the pandemic virus because no vaccinations are currently available. Physical contact between individuals can help to reduce the risk of virus transmission.

As a result, the study's purpose is to create a deep learning system that can identify the social distance from above. “The system utilizes the YOLOv3 object recognition paradigm to distinguish persons in video sequences. The model's accuracy is enhanced through the transfer learning process. A pre-trained algorithm is coupled to a second trained layer that uses more human data in this method's detection process. Bounding box information is used to identify people in the detection model. The pairwise distance of people from the provided bounding box centroid is calculated using the Euclidean distance”. We used an approximation of physical distance to pixel to establish a violation threshold to determine the social distance barrier. Individuals in video sequences are also detected using a tracking algorithm, so everyone who breaches or over the social distance threshold is tracked.

2.3 Face Mask Recognition

Facemask detection is a technique for determining whether or not someone is wearing a mask. The issue is modularizing face mask detection, which entails recognizing a person's face using a range of machine learning approaches for safety, identifying, and monitoring. Computer Vision and Pattern Recognition rely heavily on face detection. A wide number of studies have previously provided effective face detection algorithms. Face detection was originally investigated in 2001, with classic machine learning algorithms and artisan design being used to build good classifiers for classification and mask recognition on the face. This approach has two weaknesses: high dimension complexity in feature design and low high tracking accuracy. Face recognition techniques are based on deep convolution neural networks (CNN) and have been widely recently developed to improve and enhance detection accuracy.

Hence, the work aims to develop a system that really can effectively detect masks over the face in crowded areas to protect against the spread of covid and thus make a significant contribution to public health. However, distinguishing faces even without masks in crowded areas settings is problematic because of the restricted dataset available for identifying face masks, which causes training of the model. As just a response, the idea of importing learned kernels from models trained on a big dataset to detect a similar face task has emerged. The collection includes photos of faces with and without masks, faces with and no masks in the same picture, as well as confused images without masks.

2.4 Social Distance Estimation

Social distance estimation refers to virus prevention measures that minimize human physical connection in public places such as shopping malls, parks, and airports. Social separation is necessary, particularly for people at high risk of COVID-related illness. The spread of infection and disease symptoms can be significantly reduced by minimizing the likelihood of virus transmission from infected to healthy people. The purpose of this work, from such a broad perspective, is to present a learned social distance monitoring system for public spaces. A deep learning method is utilized for human activity recognition. The overhead set of data is used to put the pre-trained system to the test. Transfer learning is also used to improve the effectiveness of the recognition model. This is the first time an overview vision viewpoint has been employed with learning algorithms to estimate social distance. Humans are recognized by the detection model, which offers bounding box data. “After human activity recognition, the distance between each identified centroid pair is determined using the detected frame and its centroid data.

The results of social distance monitoring were produced using a learning algorithm. As can be seen, the model's recognition performance improves after learning methods are applied.” In the following sample frame, those in the green rectangle maintain social distance, while those in the red rectangle bridge the social gap. (Ahmed et al., 2021)

2.5 Automatic Number Plate Detection

Devices can scan car license plates without the need for human involvement using computer vision technology known as automatic number plate detection (ANPD). This means that video or photographic footage from the camera can be used to gather and identify any number plate.

One of the most accurate uses of computer vision is in ANPR. Vehicle registration plates are read automatically using optical character recognition (OCR) with these systems. Cameras capture high-speed images of number plates, and image processing software is used to recognize characters, authenticate their sequence, and translate the number plate image into text.

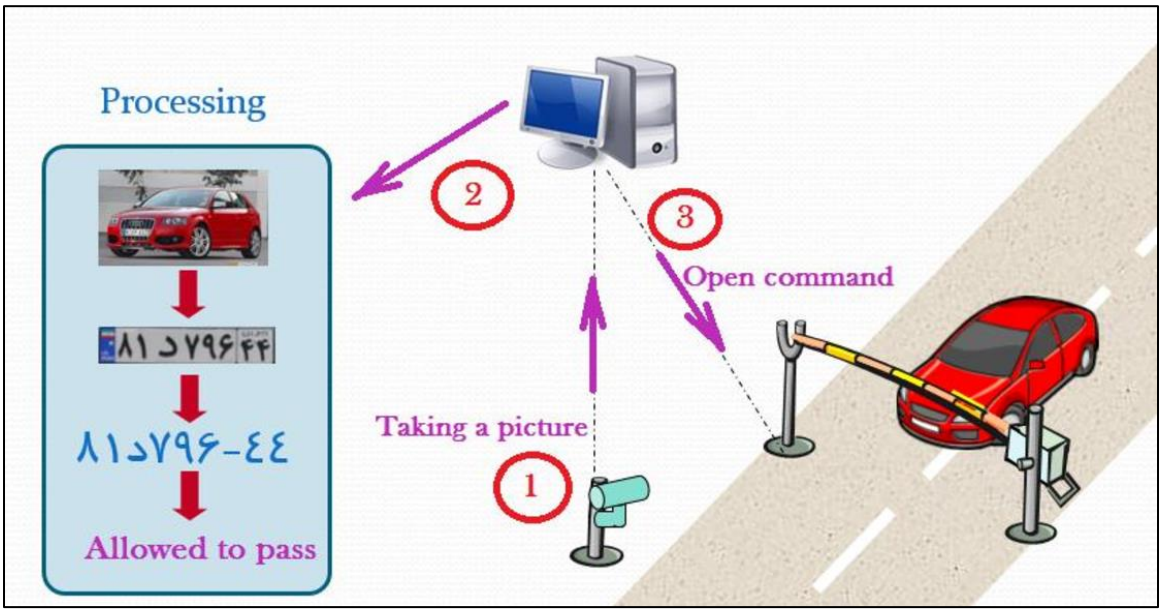

Figure 3. Automatic Number Plate Detection

A computer vision collection device, a processing unit, and multiple video analytics algorithms comprise an ANPR system. Furthermore, the use of infrared lighting allows such devices to acquire vehicle license plate information. To begin, the ANPR camera photographs license plates. Machine learning and computer vision techniques are then used to identify the plate. The license number plate area is returned using optical character recognition software. Typically, the converted number is maintained in a database for usage in other IT systems. (Automatic Number Plate Recognition (ANPR) - Overview - viso.ai, 2022)

2.6 Advantages of Smart COVID Violation Detector

With the use of this Smart COVID Violation Detector, we can determine whether some areas have received more COVID than others, this will aid the prevention of viruses by implementing the certain important procedure as below;

1) preventive crowd management and awareness
2) organization and crowd health safeguard
3) formulate health plans
4) traffic control
5) not only disease but all communicative disease
6) Using this as an example we formulate various other policies that can help prevent such other pandemics

2.7 Related Works

2.7.1 Face Mask Detection's Related Work

In recent years, object recognition systems based on deep learning models have potentially become very powerful while being effective and low in tackling tough jobs. For example, making a real system or model that is capable of evaluating whether or not people are wearing masks in public places.

Shaik and Ahlam utilized VGG-16 to identify seven faces in real-time neural learning knowledge to categorize and distinguish feelings. This method works during the present Covid lock-down time for minimizing transmission cases. (Hussain and Salim Abdallah Al Balushi, 2022).

In addition, Ejaz et colleagues used major component analysis to discriminate between people with masked and unmasked faces. (Principal Component Analysis on Masked and Unmasked Face Recognition, 2022)

Li, etc. Used by humans, convolutional neural network are a subclass of deep neural networks that are often used to assess visual imagery when learning in the deep. While matrix multiplications come to mind when thinking of a neural network, that is not the case with ConvNet. An algorithm known as Convolution is used. When it comes to mathematics, convolution is a mathematical procedure that produces a third function that expresses how one function is influenced by the other. The pre-and post-associate rate is 93.64%, and the left and the right associate rate is 87.17%. (Visit 2022 COVID-19 During the epidemic of coronavirus disease, the position of the multi-angle head part is classified according to the time,2022)

Qin and Li developed a face mask detection design using the scenario identification method. The paper broke down preprocessing the image, reducing the face regions, super-resolution operations, and predicting the end condition into four sections. The use of super-resolution to improve visual quality was the research's key originality. The author's proposed method used SRCNet to detect face masks and their placements with a 98.7% accuracy. (Qin and Li, 2022)

The authors employ the darknet-53 (YOLOv3 algorithm) to detect face masks. Machine learning and artificial intelligence are combined in deep learning. Machine learning that is impacted by brain cell activity has shown to be more adaptable and produce more precise models.

2.7.2 Related Work of Social Distancing Monitoring

Social separation is essential in a confined environment to address the existing circumstances surrounding the transmission of COVID-19. The most challenging component of this surgery was calculating the safest distance, and the outcome was critical in revisiting the case. For use in offices and schools. A mixed Wells-

Riley model was employed in one study to estimate the likelihood of infection from an airborne virus, which is the primary source of social distance. Their study revealed a distance of 1.6 meters. When examining the virus's air transmission, 3m was judged to be the safest potential social distance. Coughing, talking, sneezing, and other ejected droplets were separated by 8.2 meters. It was recommended that a quiet air environment be studied. By doing so, they validated their model and found that maintaining social distance can help to minimize illness transmission. (Sun and Zhai, 2022)

The other study focused on determining the spread so that appropriate prevention techniques might be employed to reduce the spread. The study employed ferrets to demonstrate that SARS-CoV-2 might be easily transferred through any sort of instant communication as well as the air. The ferrets were ill from 1 to 3 days after being infected, with symptoms lasting between 3 and 7 days. The discovery provided experimental corroboration of the virus's vertical transmission, allowing society to employ social distancing, which is currently used in several nations. (Richard et al., 2022)

Another study looked at the influence of social distancing measures enacted in 10 different countries. The authors focused on proven COVID-19 cases and deaths in ten significantly afflicted countries, including Spain, Italy, Iran, and others. They focused on how these countries responded to the pandemic between January 11 and May 2, 2020. The effectiveness of this technique was evaluated through the use of social distance and its relationship to COVID-19 cases. According to their research, evidence of reducing incidences appeared 1 to 4 weeks after the announcement of social separation measures. The results vary due to the different approaches followed by each country. (Thus et al., 2022)

Another study investigated the role of culture in social distancing around the world. For 58 nations, the author used data from Google Communities as well as Hofstede's cultural factors. As a result, the author arrived at a conclusion in which they suggested efficient solutions for virus containment by considering the impact of uncertainty. (Huynh, 2022)

A different method was used in a research study to examine the impact of social separation. They devised a way for promptly assessing persons who were assumed to be asymptomatic. By utilizing their model on the data they obtained, they discovered that persons who self-isolated or kept social distance reduced or delayed the date of an outbreak. As a result, they believed that implementing a strict social separation mechanism in all counties would contribute to stopping the various from spreading. (Aldila et al., 2022)

Any academics were anxious to explore if the social distance measurements were useful and if lowering some of them could help prevent a second wave. According to the research they conducted, social distancing measures helped lower virus transmission and infection encounter rates. They stated in their study that boosting case detection accuracy was essential to decrease virus replication and that several other protective measures should be developed to strengthen personal protection and compensate for the severe social distancing measures. (Wu et al., 2022)

2.7.3 Automatic Number Plate Recognition's related work

Researchers claim that the plate finding structure is an embedded framework that mechanically recognizes the vehicle's license plate. The applications range from a security framework for parts and assemblies to an indefinite zone, and from stopping to monitoring city activity. Because of variables such as brightness and speed, programmed tag identification has grown more difficult. These frameworks are similar to created devices in Matlab. This document describes how to use the

automatic number plate detection framework in conjunction with Python software programming and the Open Computer Vision Library. (Jain et al., 2022)

The detectives investigated if a specific number of vehicles is restricted and how they are regulated through section resistance and trade running. In travel administration, plate extraction is routinely utilized to assess a scenario. A vehicle whose owner's name has violated mobility laws. A system for recognizing and locating car registration plates is utilized in exchange-connected applications such as the investigation of a stolen vehicle. It would be preferable if the car license plate was automatically removed from the taken images. The number plate recognition technique had a problem with the highlight identification process. The current technique for number plate identification is based on a point of insertion on a limited collection of data. (Sharma et al., 2022)

The engine vehicle enlists cover identifies the expanding area within the improved image giving out. Following the voyage, the number cover is detected using a tape camera at several places utilized for take-offs. Normally, the methods for transportation enrollment cover change. (Kaur et al.,2022)

The researchers have a well-organized look and hear about the medium acceptance information stolen from halting and starting in a few various sites in metropolitan areas. As a result, they planned to place CCTV cameras on every sign in the region to track stolen media. Install a numerical plate recognition system capable of distinguishing each vehicle's whole number plate on the interchange sign. A large amount of work has been made for detecting car number plates, but they constantly lag behind embryonic every year. The execution of essential procedures such as preprocessing, image conversion from RGM to Gray, edge detecting, and morphological administrators on numeric plate placement framework picture preparation all play an important role. (Sonavane, ET, et al, 2022

CHAPTER - 3

3. TECHNOLOGY REVIEW

3.1 Arduino

The Arduino Uno microcontroller board based on the ATmega328P microprocessor that was developed by Arduino. cc. It features 14 digital and analog input/output pins. These pins are capable of connecting to various expansion boards and other devices.

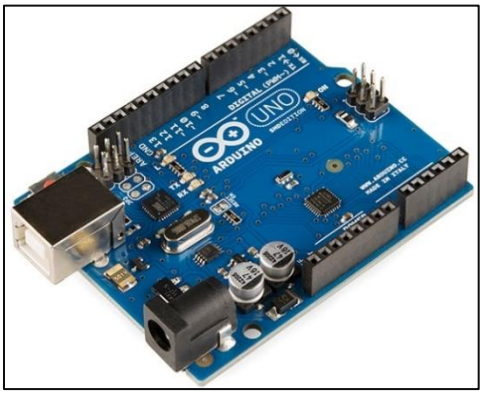

Figure 4. Arduino Uno

3.2 Buzzer

The buzzer is a tiny speaker that is used to emit a tone at a specific frequency that is directly connected to the Arduino. Another name for the Arduino buzzer is a piezo buzzer which makes sound by using the piezoelectric effect in reverse. This is used in this project for the message alert if anyone violates any of the rules.

Figure 5. Buzzer

3.3 Arduino male to Female Wire

A male connector is also known as a plug that has a solid pin for the center conductor and a female connector is known as a jack that has a center conductor with a hole for accepting the male pin.

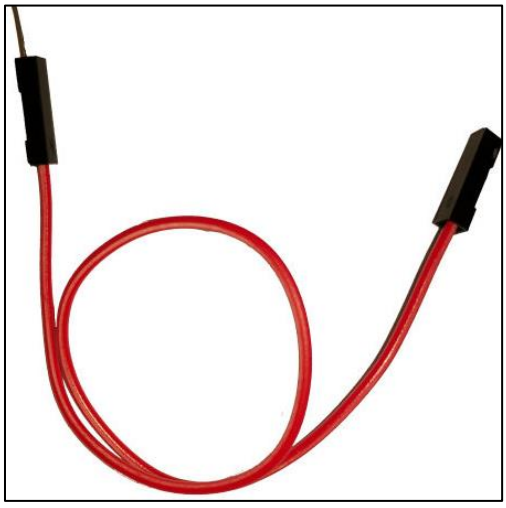

Figure 6. Arduino male to female connector

3.4 Webcam

A webcam is a digital video device that is developed into a computer. A tiny grid of minuscule light detectors integrated into an image-sensing microchip collects light through a small lens just like a digital camera.

Figure 7. Webcam for web camera

3.5 Theoretical Framework

3.5.1 Artificial Intelligence

As the world is digitalizing, Artificial Intelligence is being more popular and important in human life. The computer-controlled robots can perform several tasks like living creatures without the involvement of humans. The major advantage of the artificial intelligence system is to perform different tasks without human intervention. After working for certain hours, humans face difficulties in working, they get tired as well as get bored of doing repetitive tasks hence, they lose their concentration but if we see the AI robots they can perform the tasks constantly with less error while producing the more accurate result. AI systems can be used in different data analyses. For example, if we see the current scenario the stock market is growing rapidly so it is kind of difficult for humans to analyze all the data but ai robots can do deeper analysis with remarkable speed.

Figure 8. Ai concept Artificial Intelligence Various Industries

Similarly, Artificial Intelligence makes our life easier. AI is expanding in both bigger and smaller businesses through discoveries and innovations. It would have been difficult to understand different languages but with the help of artificial intelligence, it takes a few seconds to translate one language into another language. Different kinds of devices are built like Alexa which can help us by performing daily life tasks. The intelligence machine helps us for different decision-making purposes, solving different problems is the main objective.

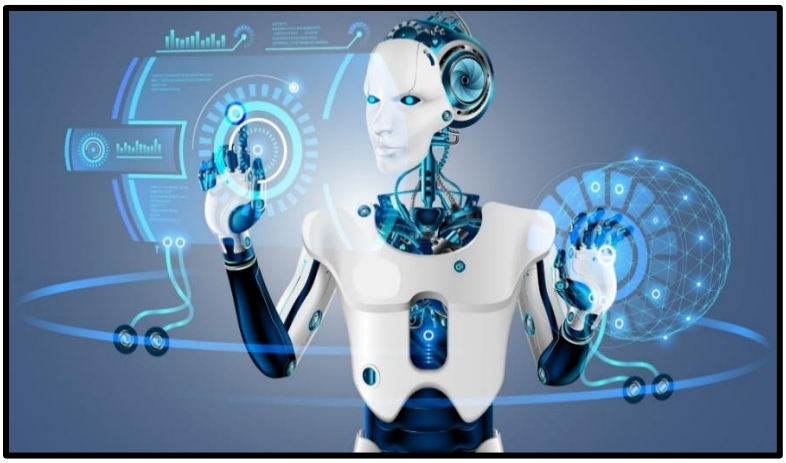

Figure 9. Relationships between AI, Machine learning, and Robotics

The role of strategies in this project is to make the Smart COVID Violation Detector where AI plays an important role by training the dataset models of face mask detection with mask and no mask. The AI system used in this project has a major role in identifying the humans with or without masks which benefits in minimizing the ongoing virus spread. This real-time system can help in managing traffic control as well as maintaining a social distance so that it controls the spread of viruses.

Artificial intelligence's aim has produced a host of issues and debates. And that's because no widely accepted definition of the topic exists. It is a software program that is capable of performing tasks that require human intelligence. Also, the majority of these ai algorithms are referred to as machines, while some rely on TensorFlow, and yet others have been based on basic things like rules.

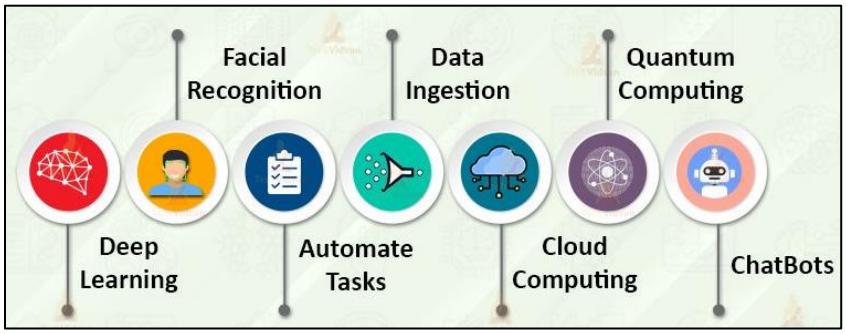

Figure 10. Features Of Artificial Intelligence

3.5.2 Machine Learning

Machine learning is an interesting topic of ai technology in which computers may learn from data, analytics, and trial and error to identify an opportunity for improvement and innovate more quickly. It uses machines to understand in the same way as humans. Most software applications depend on code to tell them what to perform, like which command to run or which data to save. So computer vision is allowing computers to acquire tactics and explicit knowledge that is learned via human experience and environment which are hard to send this kind of knowledge vocally or in writing.

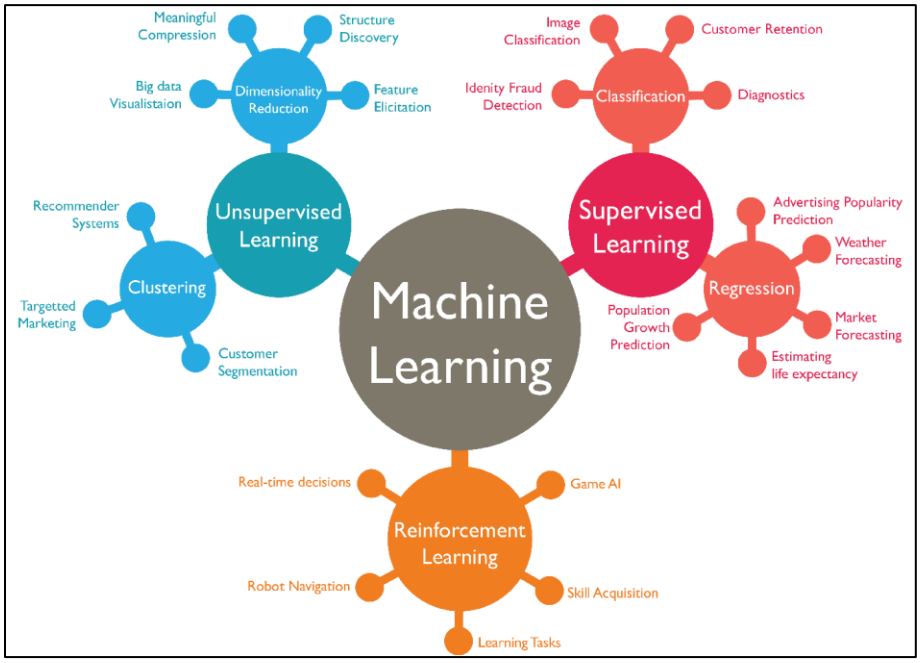

Figure 11. Machine Learning

As we know, a face recognition system is an example of metacognition. We can distinguish anyone's face but explaining how or why is challenging. To recognize someone based on looking at their face, we depend on our knowledge banks to automatically link the dots.

Machines do not need millions or billions of lines of code to do operations. Deep learning empowers computers with knowledge, allowing them to make connections, uncover patterns, and make predictions based on what they have learned from the past. The utilization of meta-cognition in machine learning has proven it a go-to tool for practically every business, from finance to environment and government.

3.5.3 MobileNet

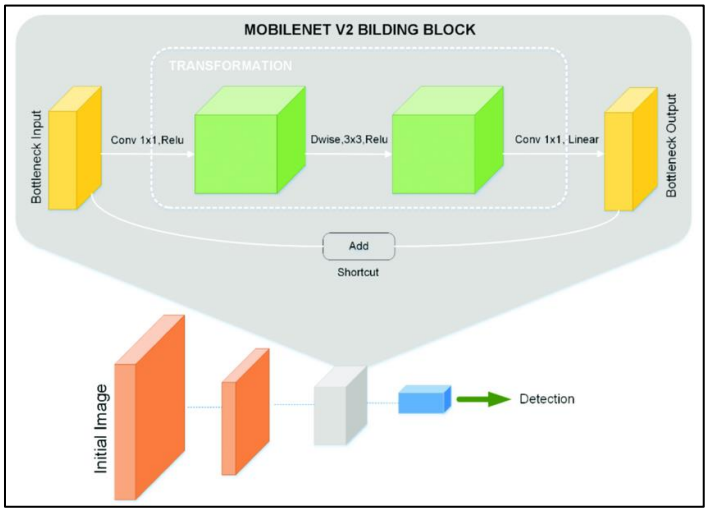

Figure 12. MobileNet – SSD Model

MobileNet is a lightweight 30-layer architecture designed for mobile and embedded devices. A single convolution is done on each color channel rather than combining and flattening all three. This technique uses “depth-wise separable convolutions. Building lightweight deep neural networks with depth-wise separable convolutions that can perform at low processing costs is the primary goal of the development” (Tsang, 2022).

The standard object detection model differs from MobileNet in that it uses a conventional convolutional layer rather than a depth-wise separable convolutional layer. Using a normal convolutional layer, all of the channels in the input image are subjected to the filter. A weighted total of the image pixels is performed at each phase, and the filter is applied to all input channels.

The convolution process combines the values of all the input channels. It is possible to run a single convolution filter across a picture with 5 input channels, for example, and the result is an image with one channel for each pixel (Culfaz, 2022). MobileNet, on the other hand, e”mploys depth-wise separable convolution in all but the first layer, resulting in a hybrid of depth-wise convolution and point-wise convolution in all but the first layer”.

In contrast to traditional convolution, depth-wise convolution performs convolution on each individual channel. There are two main functions of the pointwise convolution: to combine depth-wise channels and to aid in the development of new features (Culfaz,2018). It is therefore possible to decompose the output of the combination of the depth-wise and pointwise convolution procedures. In regular convolution, the filtering and combining are done in a single phase, whereas depth-wise separable convolution does it in separate steps, requiring less processing and allowing for much quicker performance (Hollemans, 2022).

3.5.4 MobileNet SSD-Single Shot Multi-Box Detector

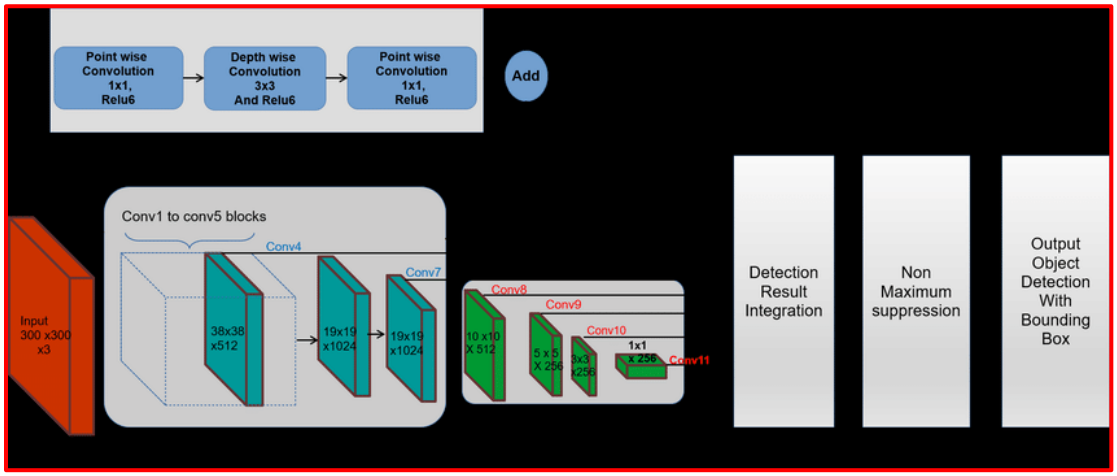

Figure 13. MobileNet-SSD Functional Block Diagram

Using an image as an input, MobileNet SSD determines the object's bounding box and category. In order to provide quick object recognition for mobile devices, this object detection approach uses MobileNet as a basis and incorporates a Deep Neural network that allows the loading of pre-trained models. This model was created using the Caffe framework. For fast object detection, a machine learning model called MobilenetSSD is proposed for use in 2022.

Using a deep neural network, we can recognize things in images, videos, or camera modules. The output space is partitioned into a number of default boxes for each feature map point at various aspect ratios and scales, as seen in this example. If the network predicts that an item type is present in a default box, it adjusts the box's dimensions to account for that presence. It is predicted that the valve network will accept a wide range of objects based on the varying resolutions of the feature maps. Since our SSD model doesn't require the production of object proposals and subsequent pixel or feature resampling, it's easier to implement

than other strategies that rely on proposals. Thus, SSD is easy to train and include into systems that require a detecting component.

Therefore, SSD is simple to learn and include into systems requiring a detecting component. SSD delivers the same accuracy as systems requiring an additional item proposal phase and is significantly faster while providing a comprehensive framework for both training and interface, based on experimental results on the PASCAL VOC, MS COCO, and ILSVRC datasets with a smaller image size. SSD is significantly more accurate than previous standards. (Single-stage approaches. SSD: Single Shot MultiBox Detector, 2022)

3.5.5 Inception V2

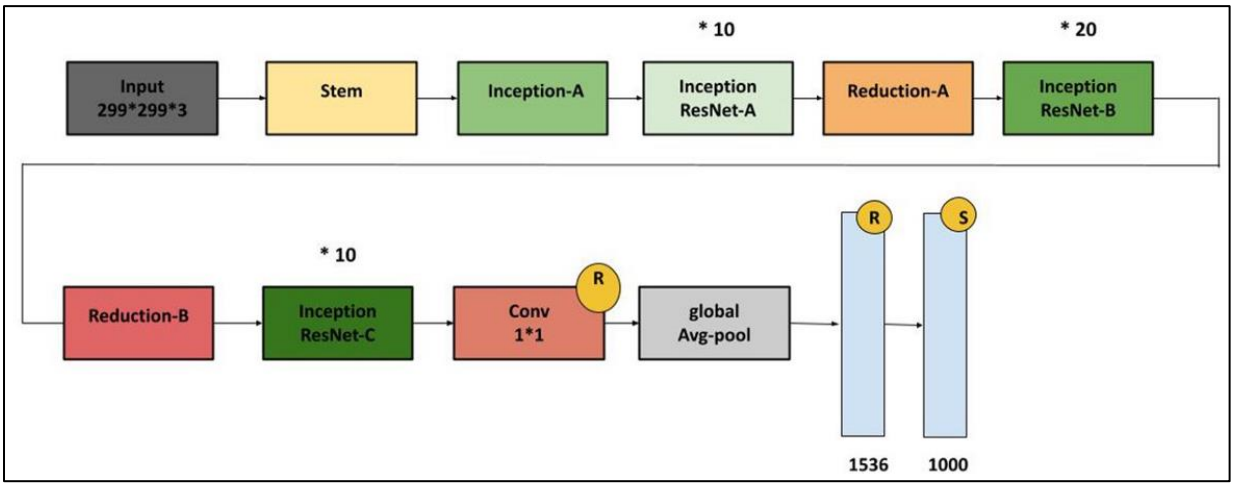

Figure 14. Inception V2 CNN Architecture

Inception is a deep convolutional neural network design that enables novel classification and detection techniques. The Inception model was created to maximize quality while taking into account computational resources. The Hebbian Principle was used to create the model, which was made possible by carefully increasing the network's depth and width.

Inception V2 is an update to Inception in which the creators are experimenting with factorized convolutions and aggressive regularization to maximize the networks and make the most of the extra computation.

The major goal of the Inception V2 was to reduce the cost of standard 7X7 convolutional operations to 3X3. The computational cost of the network was substantially lower than GoogLeNet and VGGNet, even though it had 42 layers (Christian, et.al, 2022).

3.5.6 Deep Neural Network

A deep neural network is a neural network with three or more layers with some complexity. Deep neural networks use a wide range of mathematical models to process data in advanced ways. Deep neural networks can replace human labor with autonomous labor while maintaining efficiency. Deep neural networks allow you to discover new applications in real life.

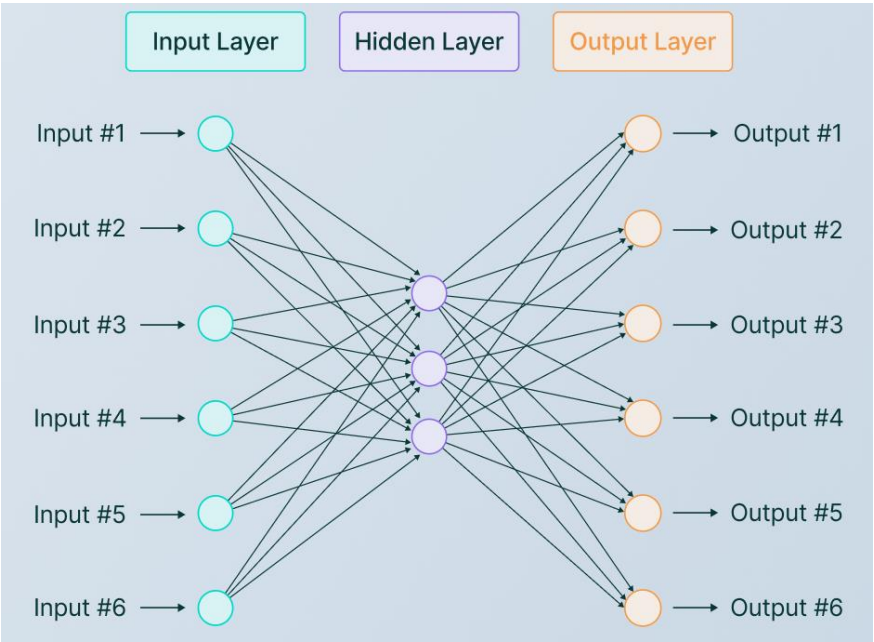

Figure 15. Neural Network Architecture

In general, neural networks are techniques developed to simulate the activity of the human brain. In particular, pattern recognition and the passage of input through various layers of simulated neural connections. Many experts define deep neural networks as a network with an input layer, an output layer, and at least one hidden layer in between. Each level performs a specific type of sorting and ordering in a process called the "functional hierarchy". One of the most important applications of these advanced neural networks is the processing of unlabeled or unstructured data. Deep learning is because the technology that uses aspects of artificial intelligence is a special form of machine learning that seeks to classify and interpret information in an order that goes beyond simple inputs. It is also used to describe the network Output log. (What is a Deep Neural Network? - Definition from Techopedia, 2022

3.5.7 Mask R-CNN

R-network CNN's has been enhanced. Mask R-CNN was made to solve the problem of segmenting instances in computer vision and object detection. It is a deep neural network that can recognize different things in an image or video, as well as provide bounding boxes, object classifications, and masks. Mask R-CNN has two main steps. First, region proposals are made based on where objects are most likely to be in the input image. Then, the object class is predicted, and bounding boxes are made along with the mask at the pixel level of the object found in the first step (Hui, 2022).

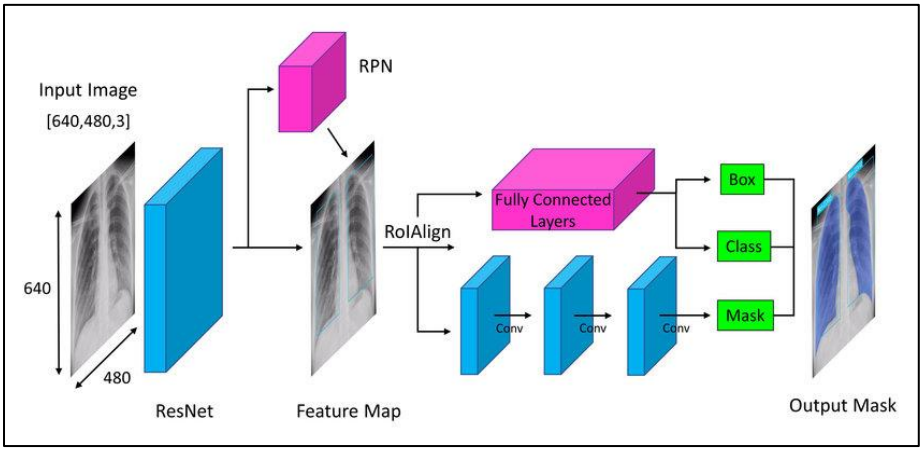

Figure 16 Architecture of Mask R-CNN

In terms of Faster R-CNN, a little tweak of adding two convolutional layers after ROI pooling creates the mask for the Mask R-CNN model, as seen in the diagram below. The inclusion of RoI Align is yet another significant improvement. Mask R-CNN employs ROI Align, which ensures that all targeted cells are the same size and that the cell boundary is not digitalized (Girshick, et.al, 2022).

3.5.8 Datasets

In machine learning, a data set is an organized collection of data bits that a machine may treat as a single entity for analysis and prediction. This demonstrates that the data collected should be uniform and understandable to a machine that does not see data in the same way humans do. It's vital to preprocess data by cleaning and completing it, as well as annotating it with relevant computer readable

tags, after acquiring it. (What Is a Dataset in Machine Learning: Sources, Sydorenko and Sydorenko,2022)

Figure 17. Datasets for Face Mask Detection With and Without Mask

A good dataset should also meet certain quality and quantity requirements. The dataset should be relevant and balanced for smooth and efficient data training. For this project, various picture formats are collected JPEG, PNG, and other pictures are collected which were a mixture of different mixture of datasets from different open sources from Face Mask Detection. Datasets are separated into two parts that are ‘with mask’ and ‘without a mask’.

3.6 Languages, Frameworks, and Libraries

The List of libraries that were required to complete this project is described below;

3.6.1 Python

Python is a programming language that is extensively used for online and application design, task automation, data processing, and data visualization techniques. Because of its relative simplicity of learning, python is being used by

people without the knowledge of programming as well, as it performs different activities such as financial planning.

3.6.2 OpenCV

OpenCV is just an excellent tool for data visualization and computer vision application. This open-source framework is used in tasks like face detection, object detection, location detection, and many more. It supports a variety of programming languages, including Python, Java, and C++. Which hundreds of algorithms and functions are freely available to us.

3.6.3 TensorFlow

An open-source deep learning framework introduced by google has been implemented as a major tool in this project. It is well-known for its information and training assistance, as well as its scalable development and installation options, several abstraction layers, and platform support. TensorFlow is a neural network symbolic math framework that is ideal for dataflow programming in a variety of applications. This allows for the development and training of models at multiple levels of abstraction. It is a sophisticated deep learning platform with a fast-developing network of local resources, libraries, and tools for building machine learning-related programs. TensorFlow, as previously said, has embraced Keras, which compares the two tasks.

3.7.4 Keras

An application program that includes high-level neural networks and is based on python programming. This open-source neural network framework based on CNTK, TensorFlow, and Theano allows for rapid deep neural network research. Keras prioritizes modularity, utility, and extensibility. It does not perform low-level computations; instead, it passes them on to the backend library. It is accessible to users via the Keras module.

3.7.5 NumPy

Arrays, Fourier transformations, and linear algebra may all be performed with NumPy's array-based toolset, which is built on top of Python. In 2005, Travis Oliphant created NumPy. It's a free, open-source project that anyone can use. Numerical Python is the acronym for NumPy. Applications can easily access and update NumPy arrays because, unlike lists, they are kept in memory in a single continuous area. Locality of reference is a term used in computer science to describe this. So, NumPy is more efficient than lists. Moreover, it has been optimized for the latest CPU architectures.

3.7.6 Matplotlib

Matplotlib is a Python-based visualization application that uses a low-level graph plotting toolbox. Matplotlib was created by John D. Hunter. Because it is open-source, Matplotlib is free to use. Matplotlib is primarily written in Python for platform portability, with a few segments written in C, Objective-C, and Javascript. (Introduction to NumPy, 2022)

3.7.7 Pillow

Pillow is a Python imaging library that extends the functionality of the Python interpreter in image processing. This library has excellent internal rendering, support for many file formats, and many image processing features. The main component of the Image library was created to facilitate access to data stored in basic pixel formats. According to the findings of this study, when dealing with photography, forms a solid foundation for processing such images.

3.7.8 PySerial

PySerial is a library that supports the serial port’s connection which includes a Python backend for the windows operating system and another operating system also.

3.7.9 Scikit-image

Scikii-image is a library of image processing methods that is available free of cost and free striction.

3.7.10 Pytesseract

In other words, Python-tesseract is an optical character recognition tool that aids in recognizing and reading text included in photographs. Google's Tesseract-OCR Engine is wrapped in python-tesseract. It is capable of reading all image formats offered by the pillow and Leptonica imaging libraries. If used as a script, it can also print the recognized text instead of saving it to a file.

3.8. Documentation, Project, and Task Management

The software that I require to complete my project successfully;

3.8.1 Windows 10 Operating System

As a primary Operating System, Microsoft Windows 10 was utilized for installing Microsoft Offices like Microsoft word, Microsoft Project, and so on for the preparation of documentation, project planning, and presentation respectively.

3.8.2 Microsoft Word

Microsoft Word was used to create documentation throughout the project's lifespan, beginning with the project definition documents and ending with the final documentation.

3.8.3 Microsoft Excel

Microsoft Excel was used to establish a risk register in which we listed the risks of our project as well as the solutions to those risks as the project progressed.

3.8.4 Microsoft Project

Microsoft Project is project management software that is used to provide an outline and comprehensive picture of the whole project schedule and tasks on a Gantt chart to be executed throughout the project lifecycle.

3.8.5 Microsoft PowerPoint

Microsoft PowerPoint is used to create PowerPoint program slides that aid in swiftly and successfully showing the end product.

3.8.6 Web Browser (Google Chrome)

Google Chrome was utilized as the primary online browser to study, examine and access project-related resources.

3.8.7 GitHub

GitHub is a version control system that allows free GitHub personal accounts where we can work on the public repositories with unlimited collaborators.

3.8.8 QSEE

QSEE is a tool that is used to create logical diagrams to make the final product which is very important for the programmer.

3.8.9 Camera Module

The camera is a product that is used to take images or videos to detect the mask on the face, vehicle number plate as well as social distance estimation by image processing and object detection.

3.8.10 Visual Studio Code

Visual Studio Code is a straightforward code editor that may be used to complete a project by executing programs like face mask identification, social distancing, and automatic number plate detection.

3.8.11 Jira

Jira is a project management tool that helps to keep the project on track to complete within a time which are implementation part and are completed part.

3.8.12 Arduino IDE

Arduino Ide is a programming tool for writing code that may be downloaded from the Arduino website. The Arduino board is a physical device that executes and saves submitted code. Arduino is both the name of the program and the circuit board.

3.8.13 Tesseract OCR

Tesseract is a platform for optical character recognition that is open source and free of cost. OCR extracts text from photos and documents.

CHAPTER - 4

4. METHODOLOGY

A methodology is a collection of techniques, activities, procedures, strategies, processes, and rules which are specific, rigid, and usually include a series of actions and tasks for every phase of the project's life cycle. (How To Write a Methodology (With Tips and FAQs), 2022). Because the topic of the project was entirely new to me, I undertook extensive research on this project. Extensive and in-depth research was conducted over there about Artificial intelligence, machine learning, the Internet of things and its functions, image processing, object detection, and Python concurrent processing. In this project, agile methodology is used which is described below.

4.1 Agile methodology

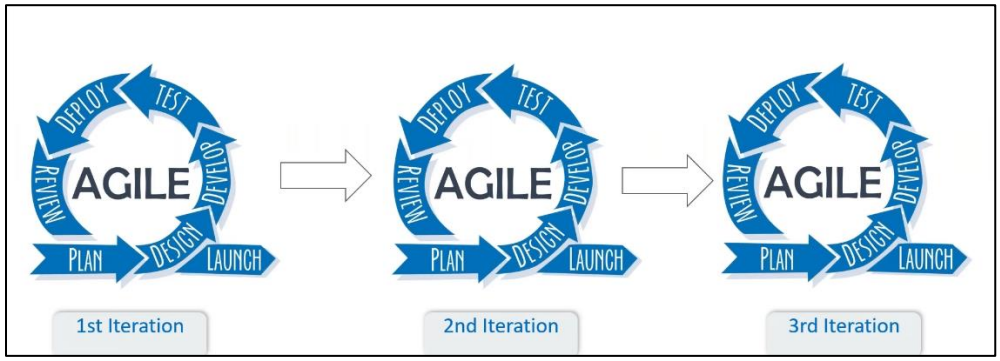

Figure 18. Agile Methodology (pay mo, 2022)

The first step in the software development process for rapid development and deployment is to break the entire application into smaller chunks of code, and then to work on each service individually to ensure that the microservices model is maintained without having an impact on the overall application. Rapid development and deployment are both terms that refer to the same thing.With microservices,

small independent services communicate with each other via well-defined APIs in an organized and architectural way.

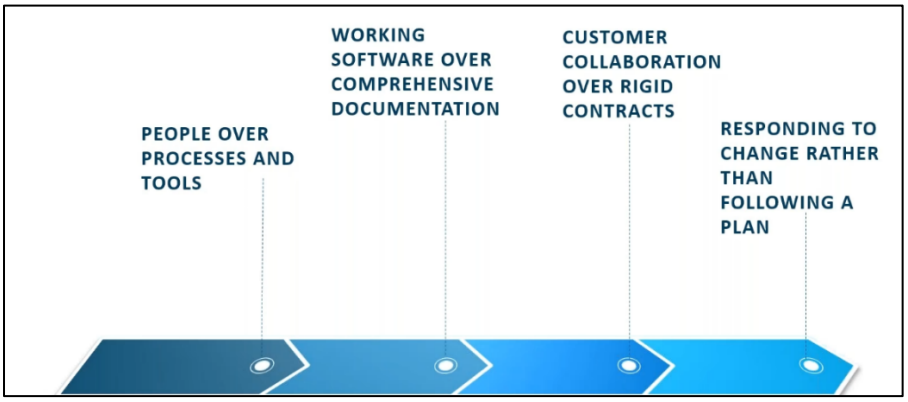

Figure 19. Values of Agile

In agile, the functional application takes precedence over documentation because code is documentation in and of itself, indicating that development takes priority over documentation. So, because agile is dependent on input, managers and product owners would hold several meetings in the past to determine the types of services they desired. Everything would be discussed over the course of three to four months, and then people would want to stick to the plan because they had already spent four months organizing this thing, and if they wanted to make even the smallest adjustment, the entire meeting and planning process would have to be redone.

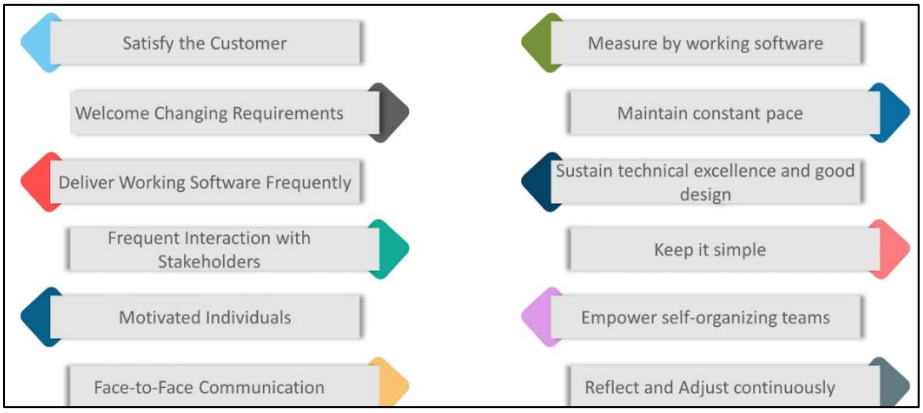

Figure 20. Showing the Principles of Agile

Now, agile differs in that it focuses more on feedback. Just because a plan has been created doesn't mean it can't be changed because things have been broken down into smaller chunks of tasks, each of which can be modified according to the requirements at any time. These are the benefits that agile brings to the table. The table of benefits and the table of values are the two pieces of the puzzle.

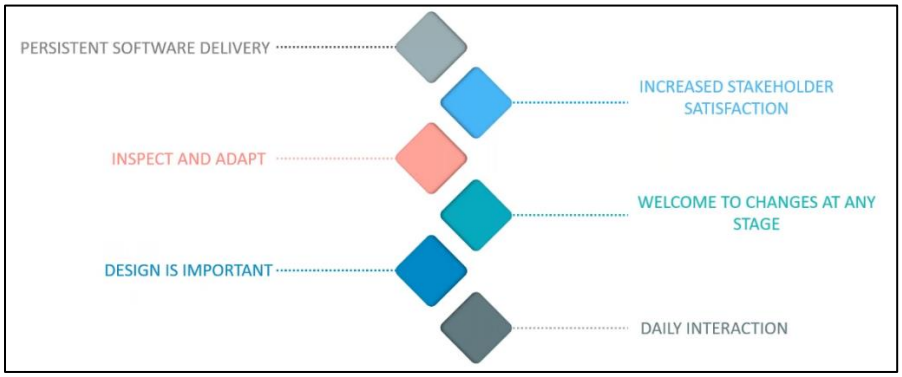

Figure 21.Showing the Advantages of agile Methodology

When it comes to agile there are multiple frameworks or philosophies where scrum, extreme programming, lean, kanban, and crystal are some popular frameworks in agile. Within this list most popular one out there is scrum. (Toggal, 2022)

4.2 Scrum:

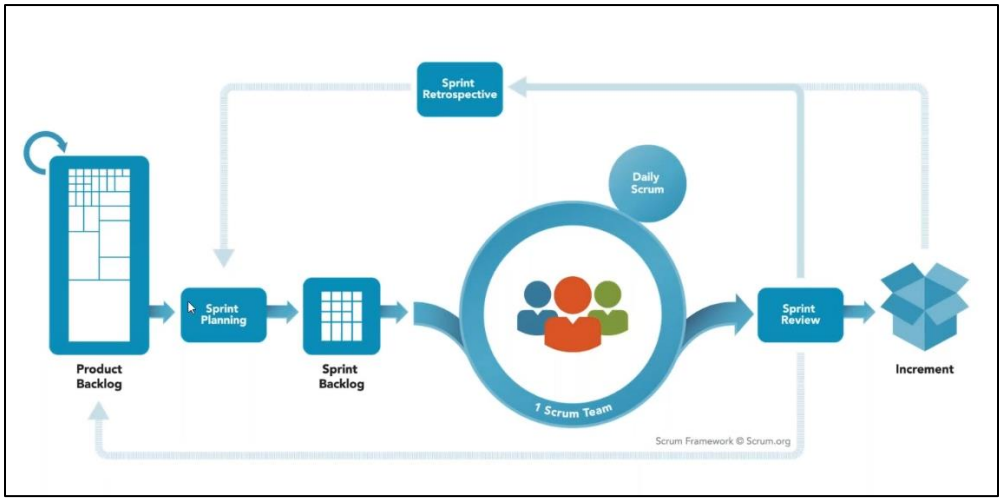

Figure 22. Process of Agile methodology

Among the various frameworks in the agile methodology, I have used the Scrum implementation framework which focuses on the workflow of the project's visual representation where the activities and tasks are carried out on a virtual board Scrum such as TO Do Issue, in progress, review and done issues as below;

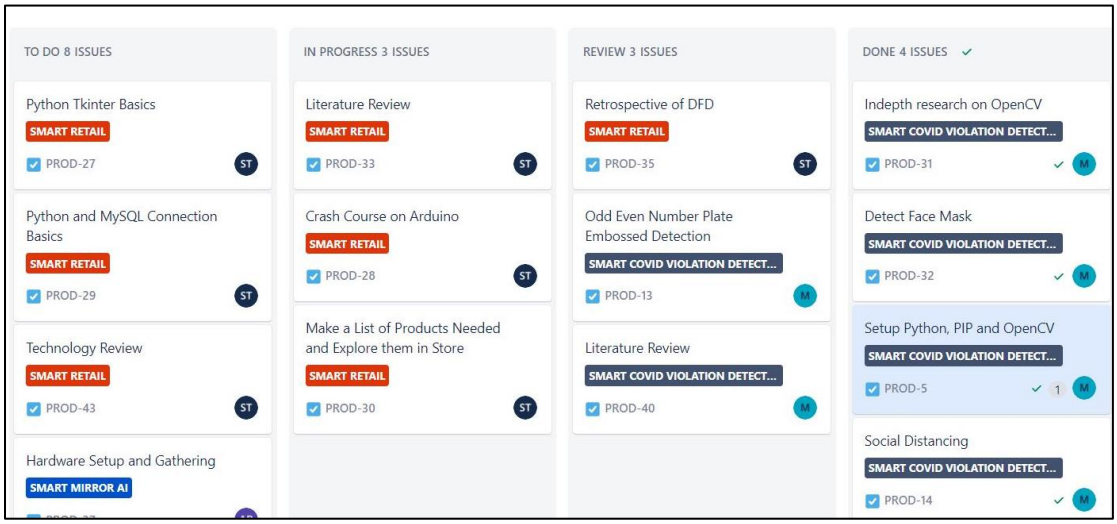

Figure 23. Scrum Methodology for the Smart COVID Violation Detector On Jira

Various identified development stages have been executed iteratively, with the completed tasks and deliverables from each iteration cycle mentioned below.

i. Project Planning and Requirement Analysis

In this stage, with the help of the module handbook, the requirements of the project were determined. Then, the requirement of the project was researched and then, the related project's title was selected according to the module handbook. After the selection of the Project's title, the objectives, features, and the scope of the final project was finalized. After the approval of the project, research was done and a literature review was completed.

Following that, the specification of the project was developed and submitted for the project's approval. Then, by following the methodology, the lifecycle of the project was determined.

ii. Product design

After the completion of the planning and requirement analysis phase, Prepared to develop an actual product by developing the conceptual models like the Use case diagram and context diagram.

iii. Development and Implementation of the project

In the development phase, the final product was developed and implemented after completing the conceptual model and then the implementation process of the project is described further.

iv. Testing and Evaluation

After the development and implementation, the final project was tested and evaluated through the black box and white box testing to ensure that the final product is as expected or not and if any bugs were found then the bugs were resolved.

v. Project Closing

At last, the end product was tested and evaluated and determined the fulfillment of the project's objectives. Furthermore, the product was presented, and the final documentation was completed and submitted to the blackboard.

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CHAPTER -5

5. SPECIFICATIONS OF THE SOFTWARE REQUIREMENT

A software requirement specification in IEEE format includes the Smart COVID Violation Detector's Functional and non-functional requirement that needs to be created. The following table shows the features of the Smart COVID Violation Detector briefly.

Table 1. Specifications Of The Software Requirement

Features	Priority
Live camera streaming	High
Object detection	High
Detect the mask on the face	High
Social distancing Estimation	High
Embossed Odd-even number plate detection	High
Notification Alert System	Medium

CHAPTER – 6

6. PRODUCT DESIGN

Before moving toward the product development phase, conceptual designs were created into developing easy guidelines to develop and visualize the eventual product. Firstly, a general overview of the system's diagram was created.

6.1 General Overview of the System

This is a high-level picture of the system, showing all of the primary components as well as the major operations that occur within it. In this project, there are three different projects and have different framework used so the overview of the system is different for every components.

6.1.1 Face Mask Detection Use Case Diagram

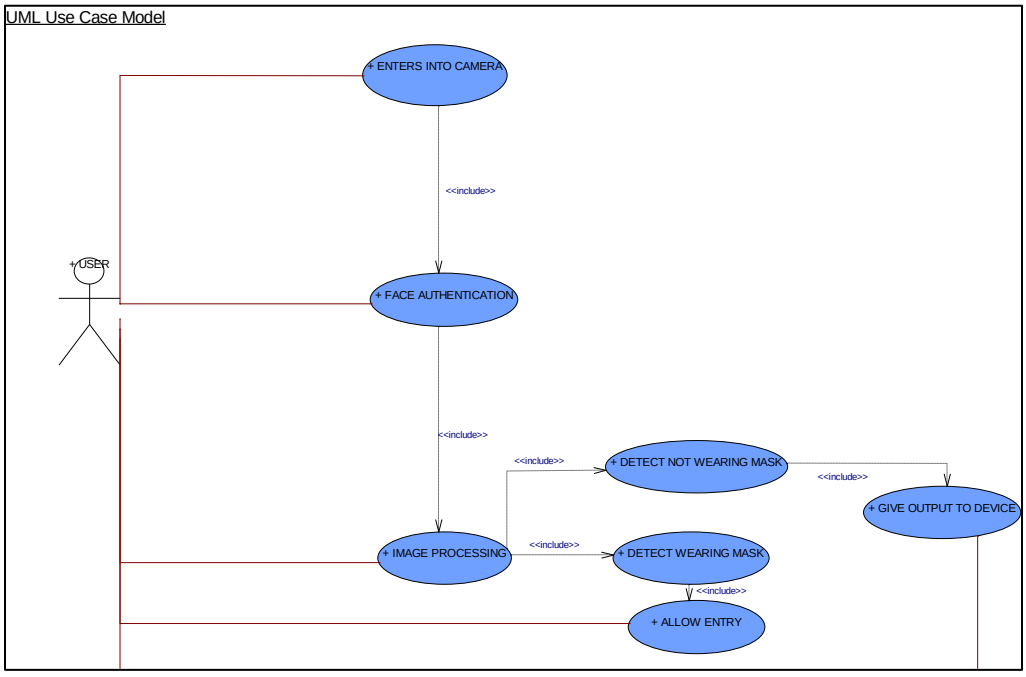

Figure 24. UML Use Case Diagram of Face Mask Detection

As shown in the above UML Use Case Diagram, first step is face authentication. Firstly, camera captures the face of a user and sends it for image processing. Then, system detects the wearing mask and not wearing mask. If any of the user is not wearing mask then alert them with playing buzzer notification.

6.1.2 Social Distancing Estimation Use Case Diagram

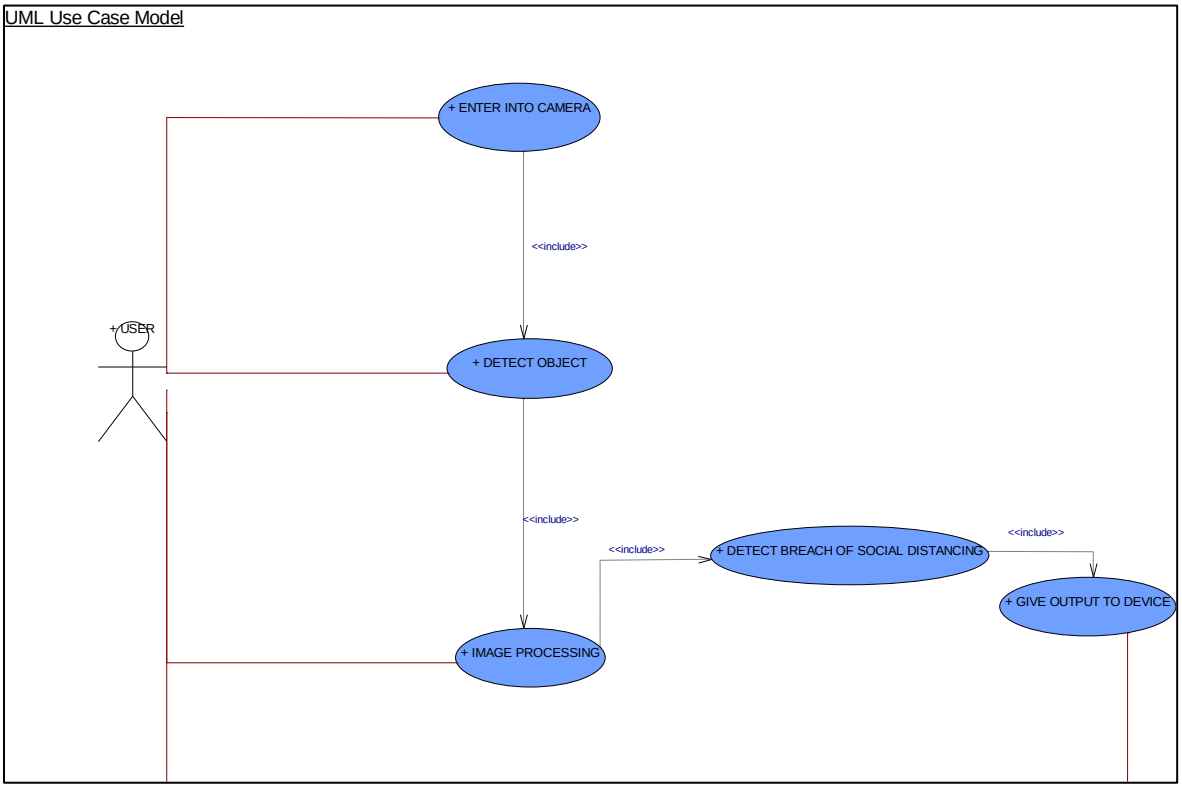

Figure 25. UML Use Case Diagram of Social Distancing Estimation

Similarly, to the face mask detection , social distancing acts same. The system first detects the user and the camera captures the live videos of the users. The video is further send for processing, which ultimately follows some algorithm to find out the coordinates and find out the distance to detect social distancing. After detecting, the buzzer comes in act which gives and output by alerting.

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6.1.4 Automatic Odd-Even Number Plate Detection Use Case Diagram

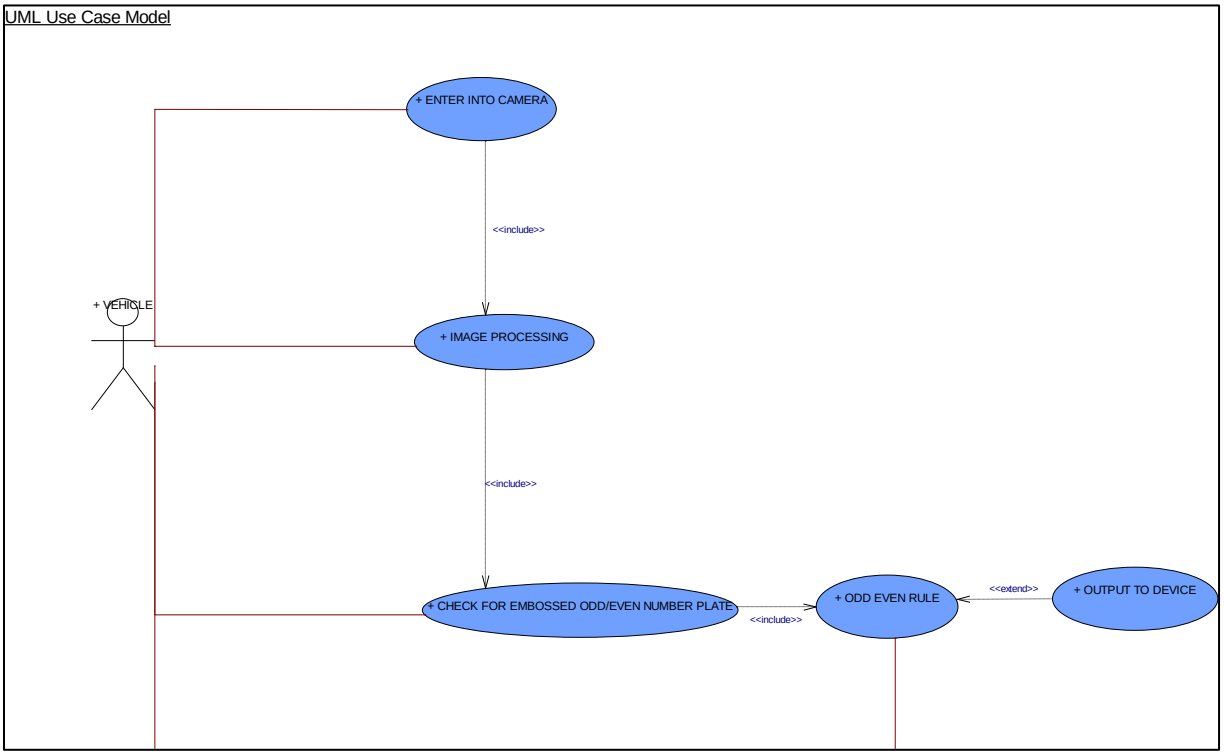


Figure 26. Use Case Diagram for Automatic Number Plate Detection

As shown in the above figure, the number plate is first captured by the camera and goes for processing. The number plate is further processed to separate whether it is odd or even and throws us an output.

CHAPTER – 7

7. IMPLEMENTATION AND TESTING

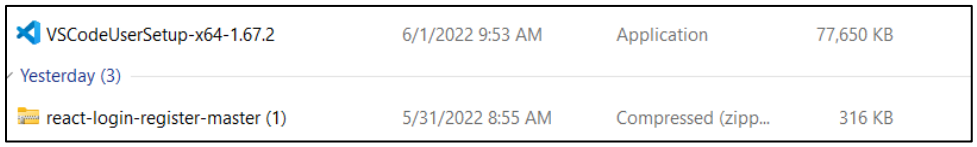
7.1 Implementation Guide for the project

As stated previously, a variety of dependencies and libraries are necessary for the research. This section contains a detailed installation guide as well as links to download the Object Detection Models such as face mask detection, social distancing estimation, and odd-even number plate detection. Finally, the rules and regulations are severely enforced.

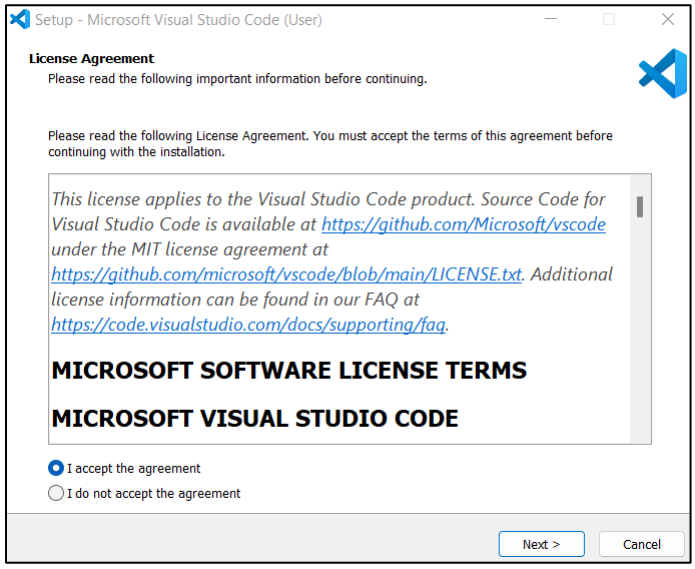
7.2 IDE Installation for implementation of the Project

7.2.1 VISUAL STUDIO CODE SETTING UP

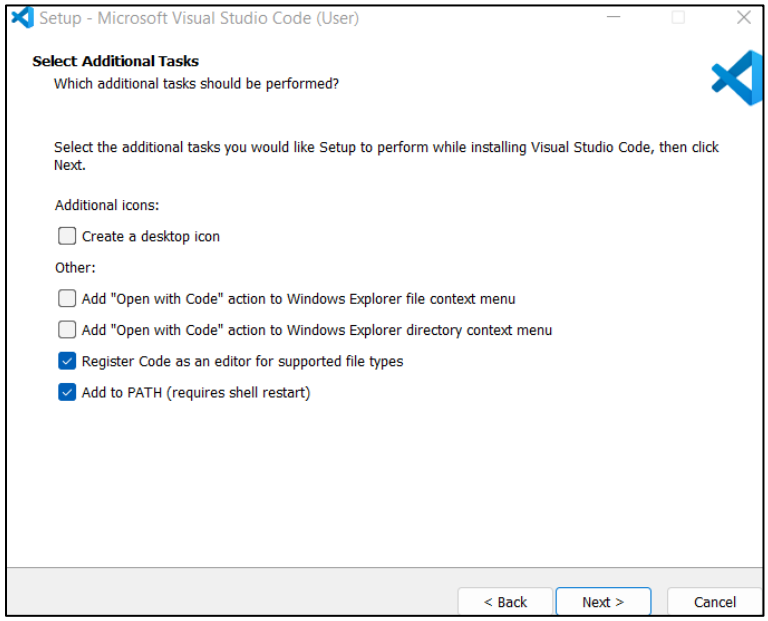
1) **Download Visual Studio Code from: https://code.visualstudio.com/**



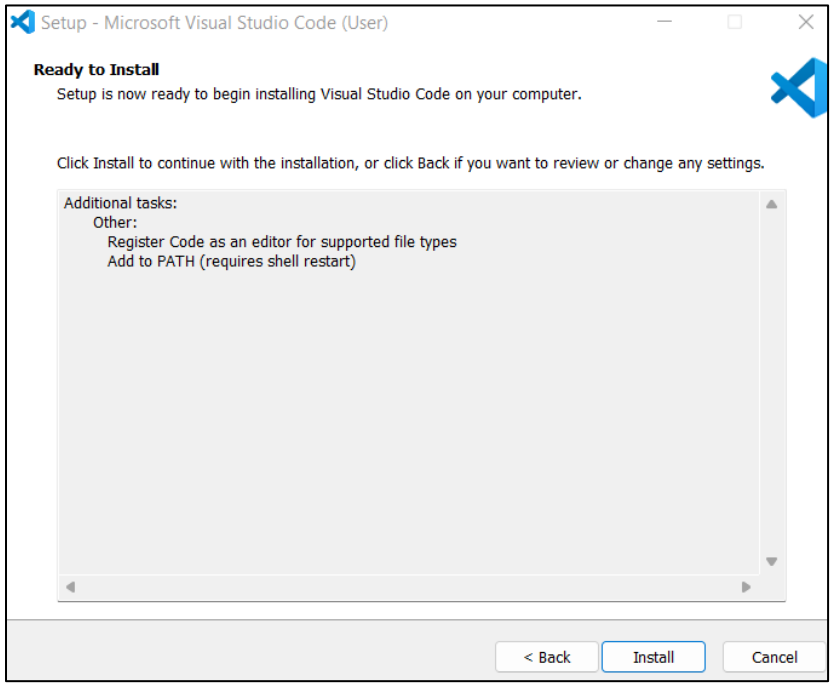
2) **Then install Visual Studio Code by accepting the agreement.**



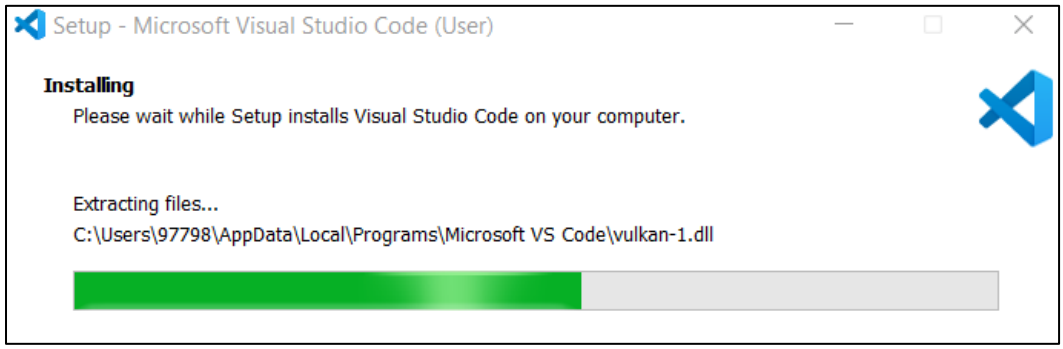
3) **Then select the additional features and click next for next step.**



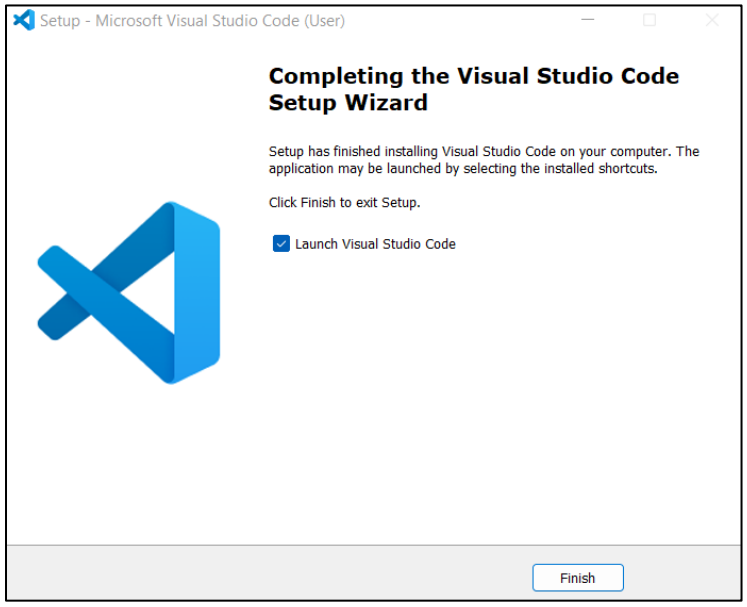
4) **After selecting the additional attributes then, it will be ready for install.**



5) **Then click install for the complete the process of installation.**

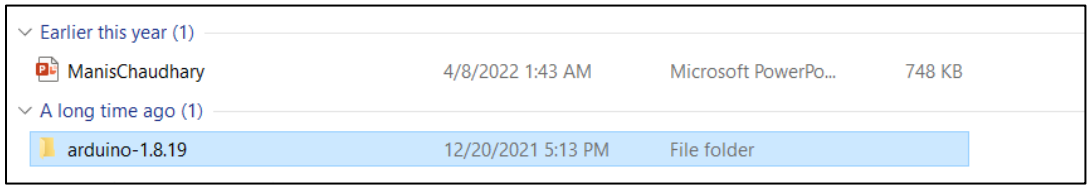


6) **Then click finish after the installation and will be ready for the utilization.**



7.2.3 ARDUINO IDE INSTALLATION PROCESS

1) **DOWNLOAD Arduino Ide from the given link: https://www.arduino.cc/en/software**



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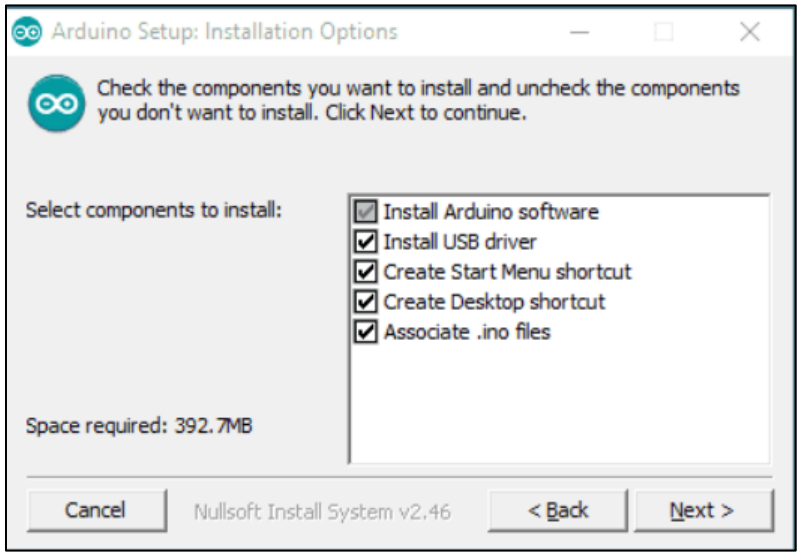
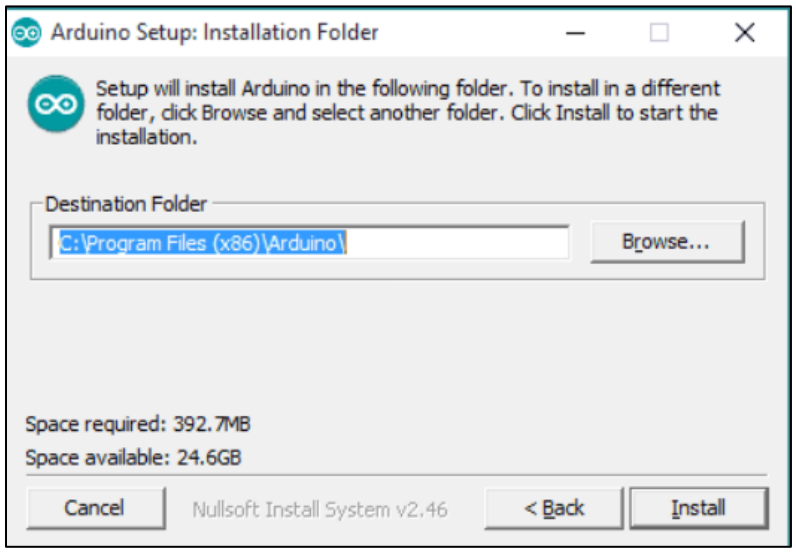
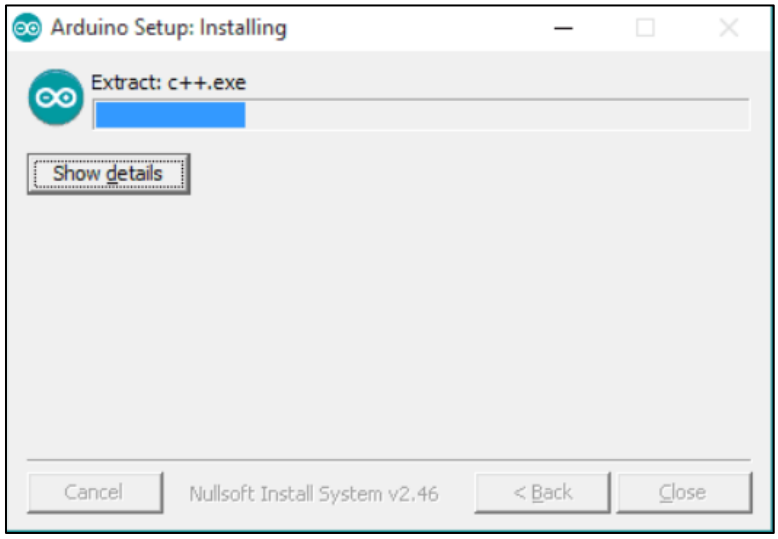
2) **Choose the components to install.**



3) **Choose the installation directory.**

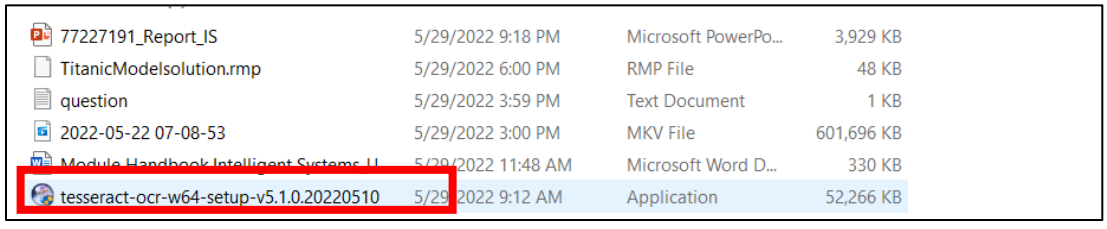


4) **Installation in progress and will be complete within few minutes and ready for use.**



7.2.4 TESSERACT INSTALLATION PROCESS

1) **Download Tesseract from:** https://tesseractocr.github.io/tessdoc/Downloads.html



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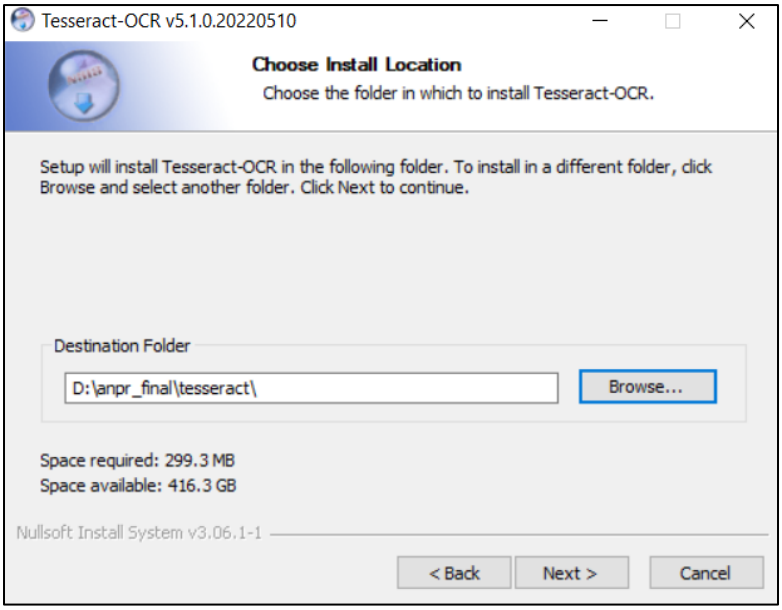
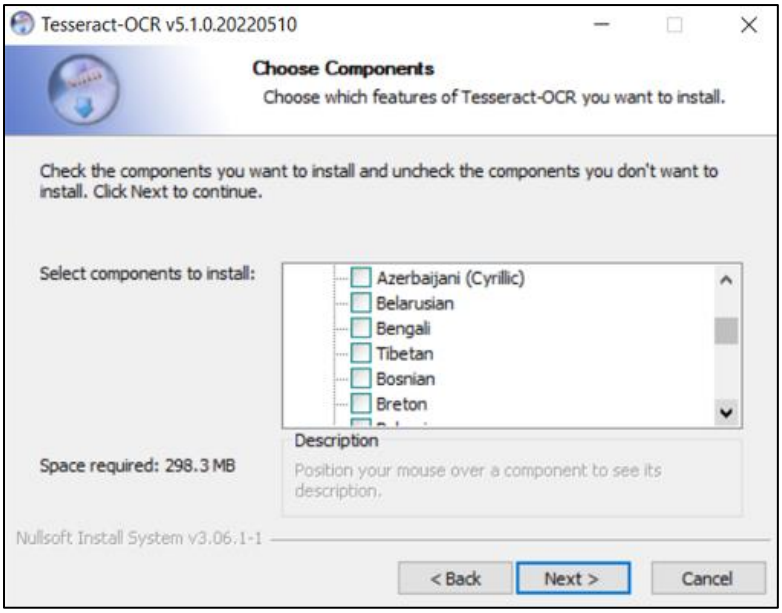
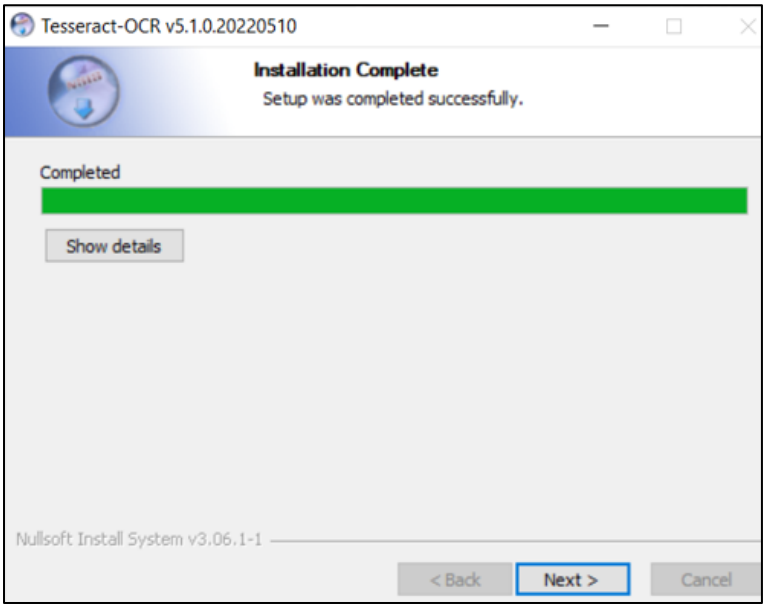
2) **Choosing the directory on the system.**



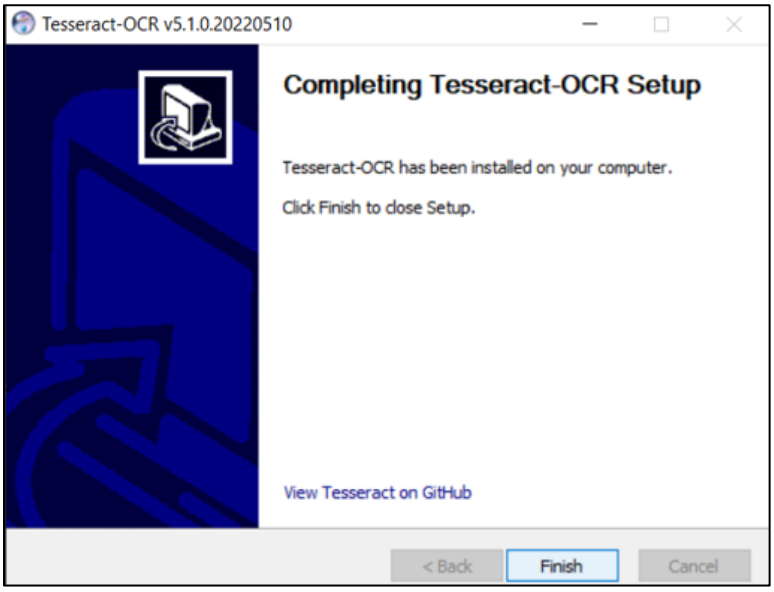
3) **Then, install tesseract by choosing the feature of Tesseract-OCR.**



4) **Then, the installation will be completed.**



5) **After installation set up will be completed and will be ready for use.**



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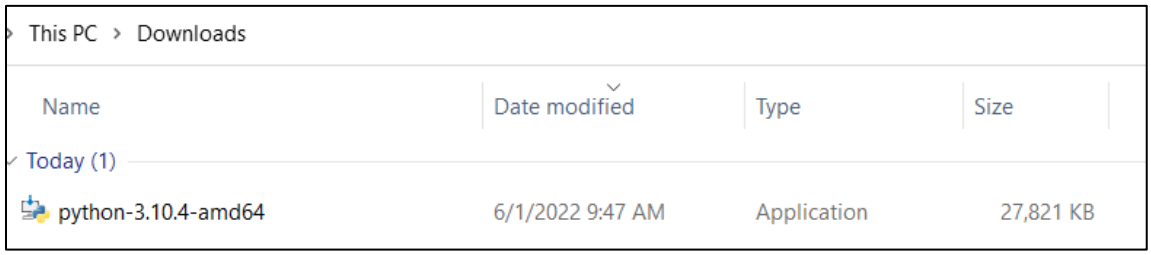
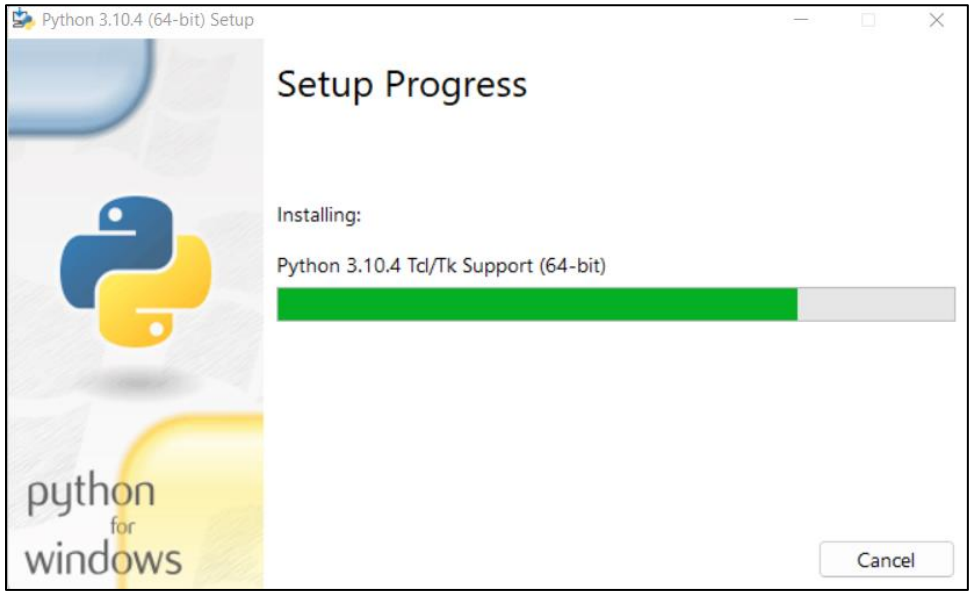
7.2.5 INSTALLING PYTHON ON THE SYSTEM

1) **Download the Python Installation file from the given source: https://www.python.org/downloads/**

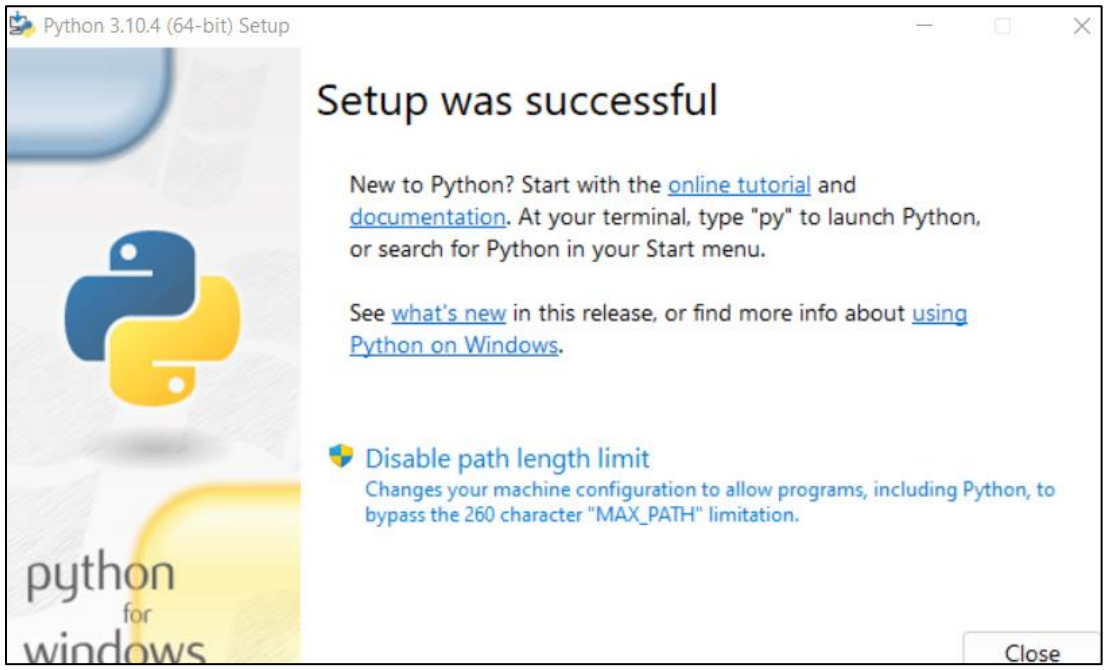


2) **The choose the component to install.**

3) **Then, the installation set up process will take few time to complete.**



4) **After few seconds or few minutes, the process will be complete and will be ready for use.**



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7.3 CREATING VIRTUAL ENVIRONMENT

```
D:\anpr_final>py -m venv venv && cd venv/Scripts && activate.bat && cd ../..

(venv) D:\anpr_final>pip install imutils opencv-python skimage pytesseract numpy
Collecting imutils
  Using cached imutils-0.5.4-py3-none-any.whl
Collecting opencv-python
  Using cached opencv_python-4.5.5.64-cp36-abi3-win_amd64.whl (35.4 MB)
Collecting skimage
  Using cached skimage-0.0.tar.gz (757 bytes)
```

7.4 INSTALLING LIBRARIES, FRAMEWORKS, AND PACKAGES

1) Installing OpenCV

```
Command Prompt - python
Microsoft Windows [Version 10.0.19044.1526]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Legion>python --version
Python 3.10.2

C:\Users\Legion>pip --version
pip 21.2.4 from C:\Python\Python310\lib\site-packages\pip (python 3.10)

C:\Users\Legion>pip install opencv-python
Collecting opencv-python
  Downloading opencv_python-4.5.5.62-cp36-abi3-win_amd64.whl (35.4 MB)
     |████████████████████████████████| 35.4 MB 1.7 MB/s
Collecting numpy>=1.19.3
  Downloading numpy-1.22.2-cp310-cp310-win_amd64.whl (14.7 MB)
     |████████████████████████████████| 14.7 MB 939 kB/s
Installing collected packages: numpy, opencv-python
Successfully installed numpy-1.22.2 opencv-python-4.5.5.62
WARNING: You are using pip version 21.2.4; however, version 22.0.3 is available.
You should consider upgrading via the 'C:\Python\Python310\python.exe -m pip install --upgrade pip' command.

C:\Users\Legion>python
Python 3.10.2 (tags/v3.10.2:a58ebcc, Jan 17 2022, 14:12:15) [MSC v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> import cv2
>>> cv2.__version__
'4.5.5'
>>>
```

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2) Following packages are installed by following command as below;

```
1) pip install OpenCV
2) pip install TensorFlow
3) pip install NumPy
4) pip install Mathplotlib
5) pip install imutils
6) pip install OpenCV-python
7) pip install scikit-image
8) pip install pytesseract
9) pip install NumPy
10) pip install pySerial
11) pip install pillow
12) pip install keras
```

7.5 Model Training For Face Mask Detection

```
model_train = model.fit(train_generator,epochs=1100,
                        validation_data=valid_generator,
                        
[16]                                                                    Python

...  Output exceeds the size limit. Open the full output data in a text editor
     Epoch 1/1100
     19/19 [==============================] - 49s 2s/step - loss: 0.8451 - accuracy: 0.5000 - val_loss: 0.6881 - val_accuracy: 0.5621
     Epoch 2/1100
     19/19 [==============================] - 35s 2s/step - loss: 0.6613 - accuracy: 0.6133 - val_loss: 0.6875 - val_accuracy: 0.5490
     Epoch 3/1100
     19/19 [==============================] - 35s 2s/step - loss: 0.6421 - accuracy: 0.6217 - val_loss: 0.6834 - val_accuracy: 0.5556
     Epoch 4/1100
     19/19 [==============================] - 35s 2s/step - loss: 0.6403 - accuracy: 0.6167 - val_loss: 0.6751 - val_accuracy: 0.6634
     Epoch 5/1100
```

7.6 Real-Time Face Mask Detection Testing

1) Detect the person's face within a camera module.

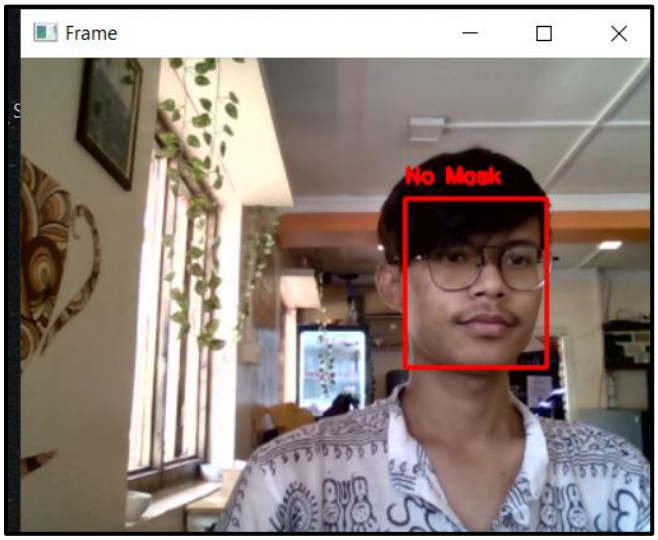

Figure 27. Detect Face on Camera Module

2) Detect the user's face with a mask

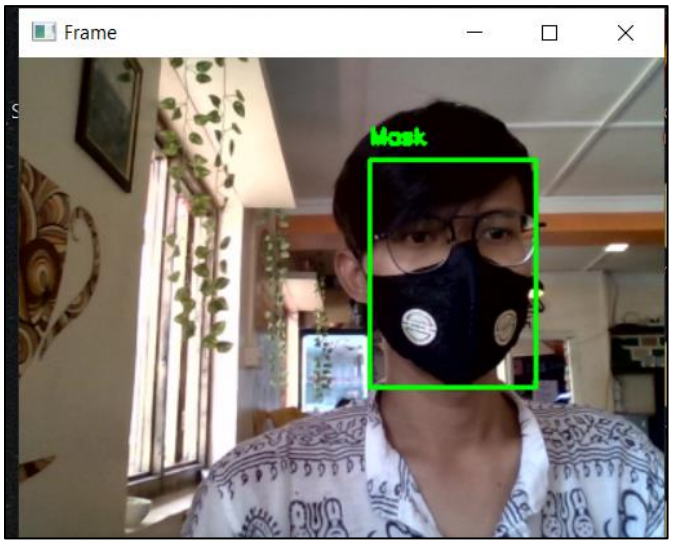

Figure 28. Detect the user's face with a mask

3) Detect face without a mask

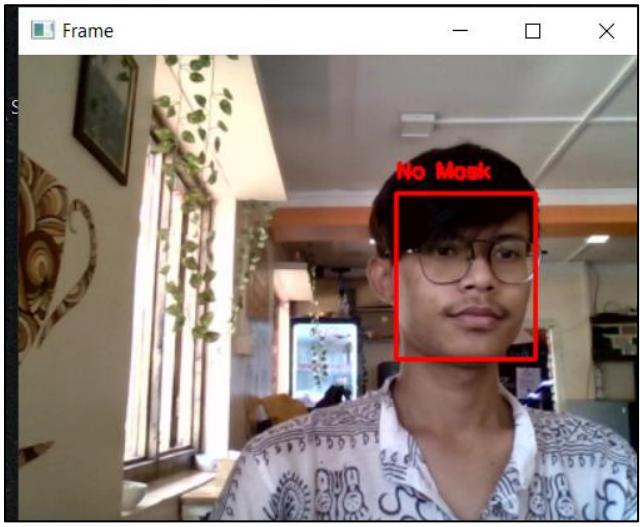

Figure 29. Detect face without a mask

7.7 Social Distancing Estimation Testing

1) Camera module within the organization estimates the social distance between people. Which are given below;

- Detect a person with high risk, If the distance between two people is 150 or less than 150 cm and give them an alert message by playing the buzzer.

Figure 30. Social Distance With High Risk on Red Zone

- Similarly, detect the person with medium risk by calculating the distance between two people is between 150 – 200 cm.

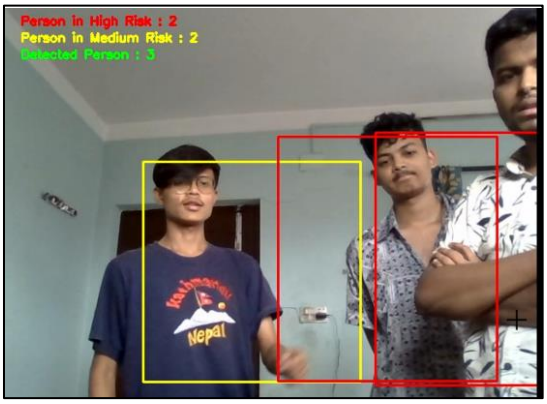

Figure 31. Social Distance With Medium Risk On Yellow Region

- Calculate the distance between two people if the distance is above 150 or 200 cm and then it will not show any risk.

Figure 32. Estimating social Distance with No Risk On Green Region

7.8 Automatic Odd-Even Number Plate Detection Testing

1) capture the vehicle number plate by the image within the camera module.

2) Detect the number plate by image processing within the system and show the output.

```
./result_sobel_overseas
./result_sobel_overseas
[INFO] Registration number: MH20EE7601
```

Figure 33. Automatic Number Plate Detection

7.9 Notification Alert System Testing

1) Buzzer Will play with the help of Arduino if anyone violates the rule. For example, if anyone is in front of the camera buzzer will play.

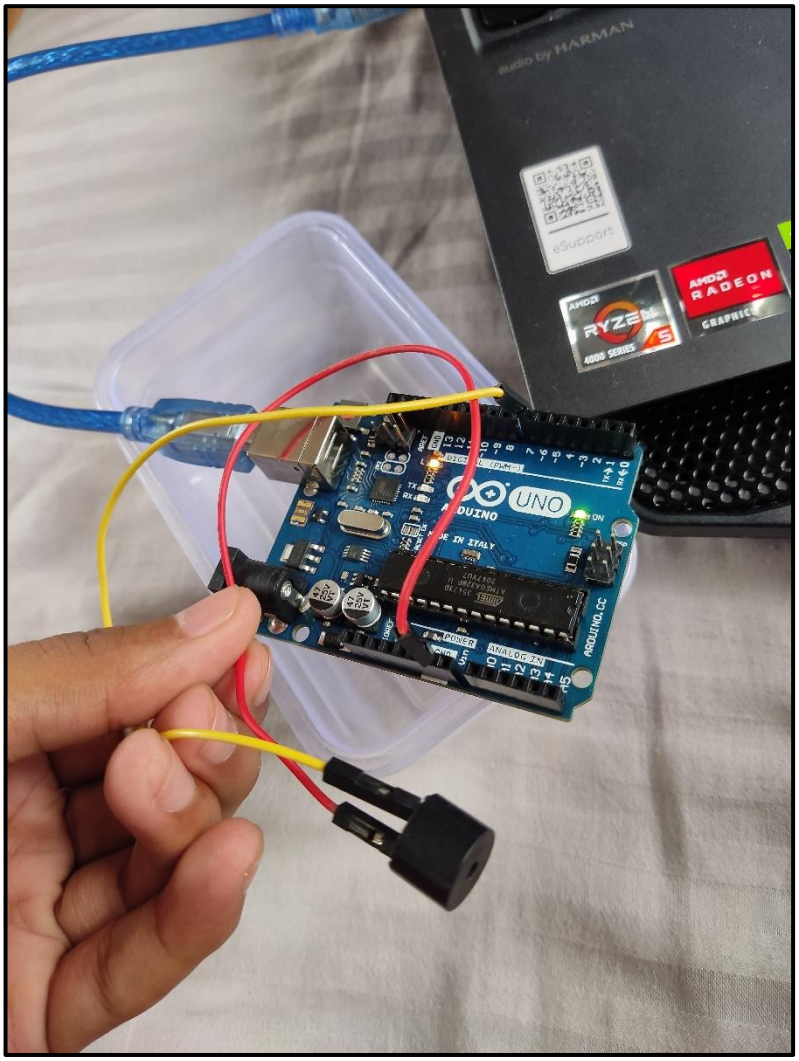

Figure 34. Buzzer Notification System

Lastly, this concludes that this project successfully works and this also shows that this will be implemented in the real-life scenario by extending the project which

helps to prevent us not only from COVID but also from many harmful viruses. For the full source code, refers to Appendix E.

CHAPTER – 8

8. PRODUCT EVALUATION

Table 2. Project Evaluation

Feature	Expected	Outcome	Evaluation
Mask Detection	The system should detect the face mask.	The system is detecting the face mask.	Success
The output of face mask detection	The result must be viewed with a mask and no mask by the system.	The result is shown by 'with mask' and 'no mask'.	Success
Load the face mask	The system must be able to load the face mask classifier model.	The system can load the face mask model.	Success
Automatic Number Plate detection	The system detects the number plate of the vehicle.	The system is detecting the vehicle's number plate.	Success
Character segmentation	The system should identify character segmentation for image binarization.	The system identifies character segmentation for image binarization.	Success
Read frame	The system read a frame from the	The system read a frame from the	Success

	surveillance camera.	surveillance camera.	
Detect human subjects	The system should detect human subjects' input frames and compute their position.	The system detects human subjects' input frames and computes their position	Success
Localized position	The system should transform the localized position from the image-pixel coordinates to the real coordinates.	The system transform position from the image-pixel coordinates to the real coordinates.	Success
Estimate the inter-personal distances	The system should estimate the distance between the people.	The system detects the distance between people.	Success
Identify the social distance violation	The system should detect the distance between people by showing 'high risk' medium risk' and 'no risk.'	The output is shown by 'high risk',' medium risk', and 'no risk'.	Success
Alert Message system	The message alert system if anyone violates the rule.	The alert message is given by playing the buzzer if	Success

		anyone violates the rule.	

CHAPTER – 9

9. PROJECT EVALUATION

The project was planned and controlled from the beginning with the aim of ensuring the project's success. To establish the tasks to complete, a work breakdown structure was created.

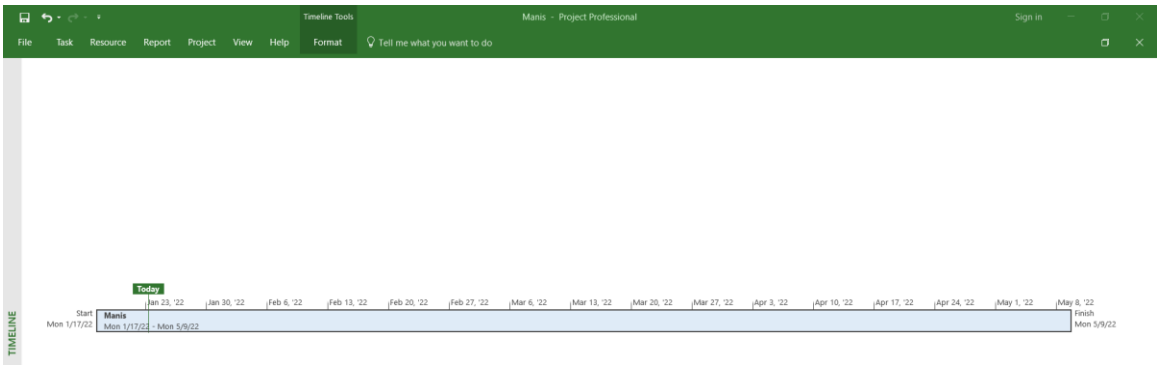

Figure 35. Project Timeline

This is the timeline for the Smart COVID Violation Detector which starts from 2022-1-17 to2022-06-05.

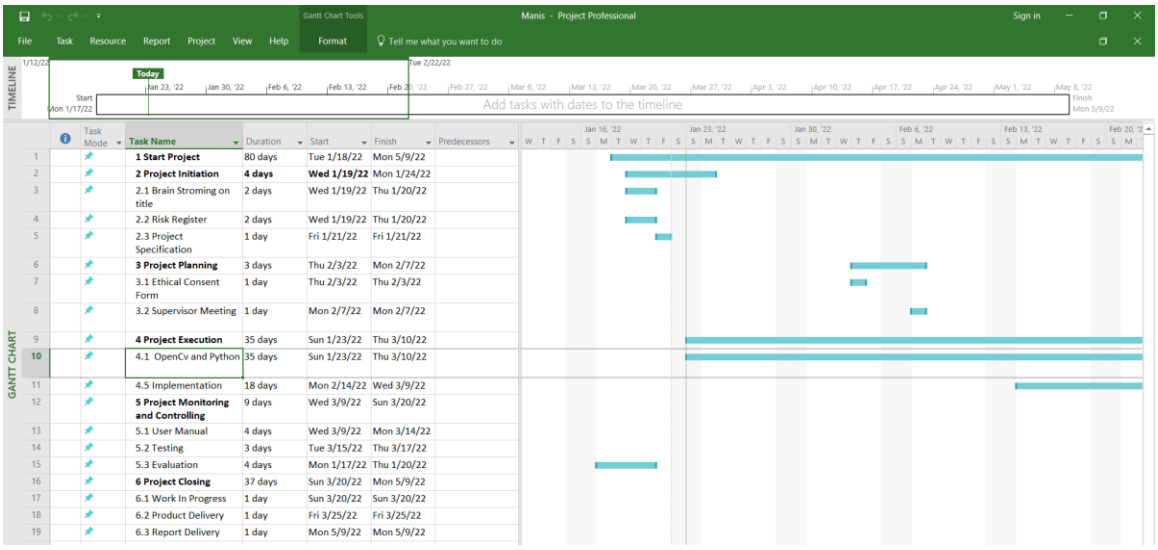

Figure 36. Gantt Chart

This is a Gantt chart for the project which is the graphical overview of the tasks and the resource given to each job that is shown above the diagram.

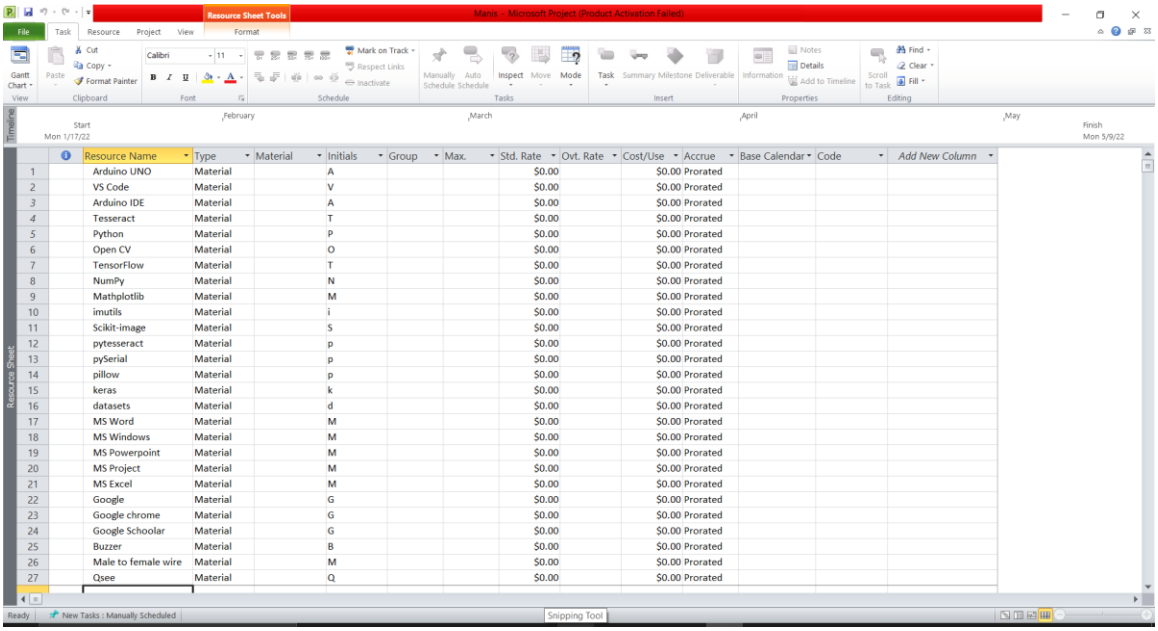

Figure 37. Resource sheet

The resource to be used during the project are represented in the diagram below.

Along with the project planning, Jira is utilized as a Scrum board to complete and tracks the tasks where Agile Scrum was employed as the development technique.

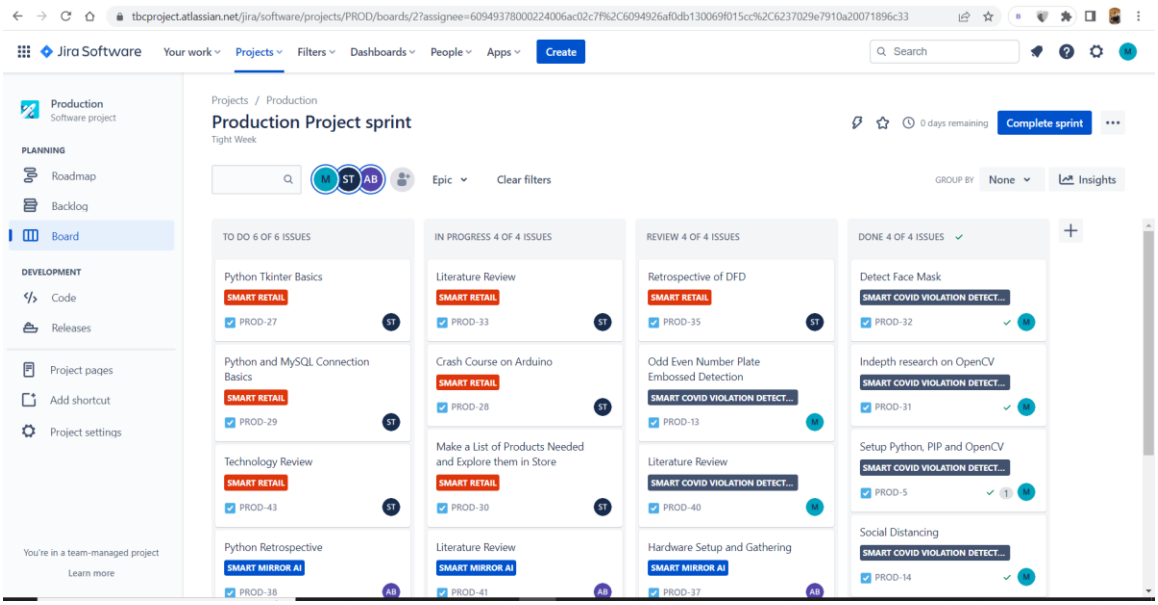

Figure 38. Jira Board development process of the project

The project was tough in general, which is because of the unfamiliar project's domain. However, the project was successfully developed which helps to learn new things through extensive research and experiment. Apart from the coding issues were encountered throughout the implementation and testing phases, where most difficult encountered throughout the project was model training of the datasets for the face mask detection.

Despite the many hurdles were faced, organizing the entire project's work with MS project, tracking the process of the tasks with agile scrum methodology, and maintaining the project's source code with git lab resulted in reaching the project's goal and completing all of the objectives within the time period.

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CHAPTER – 10

10. SUMMARY AND CONCLUSION

This project is composed of three different components to form a single component. So that it will be easy to use and understand. This project usage different libraries and frameworks to make it easy to implement. The first component of this project helps to detect face masks which helps to minimize different types of viruses. Similarly, Social distancing is another major component implemented in this project which could be very helpful in managing crowded areas. Likewise, the automatic number plate detection helps us in various ways such as detecting odd and even number plates, traffic could make use of it not only during lockdown periods but also during the normal time to keep the surveillance upon the vehicles used for criminal activities. Since the product has been evaluated and tested thoroughly, which fulfills all the objectives. Another important component of this project is to alert the people who breach the rules by alerting the buzzer which has been implemented with the help of Arduino. Easy to implement and cost-effective of this project makes it more reliable and flexible.

The extended version of this project can be very fruitful in the future as this is just a prototype. The number plate detection can be expanded and can be very helpful in real-time. The traffic management can take many benefits from it such as not only surveillance the vehicle during the covid time but also can be used in normal times also. We can implement database of all the vehicles and manage different types of traffic offences for example if a vehicle number ABC violates a rule of red light, the details related to that vehicle could be seen at traffic control system and could be given punishment according to law at the real-time. Further, the social distancing can be expanded by associating it with the voice command control system. Which could be fitted in various CCTV cameras and speakers fitted in it.

Since after the COVID various types of other viruses are emerging and even for the normal common cold, it is very important to use a face mask. Further to improve this project, we can add more codes and logic so that it verifies a person with different diseases by using the retina, nose if the mask is not put on or the behavior of that person. The system could be fitted in different security cameras which helps in verification of the health issues.

To sum it up, the project fulfills all the objectives and functional requirements as mentioned in the initial project plan. Thus, the project is concluded.

10.1 Limitations

The system of vehicle license and number plate recognition has been a major focus of this project in image processing and monitoring system. With the introduction of high-tech cameras, number plate recognition system have a wide range of usage in COVID time to control crowd as well as major use in traffic control systems.

During the development process of the number plate, there are many problems are occurred. To complete the project successfully, we need to have datasets of the vehicle number plates. But unfortunately, the number plate datasets are unavailable because of personal privacy concerns. The automatic license plate recognition system continues to have a number of issues. The non-uniformity of license plate number models for different cities and countries is the most typical difficulty then encountered. They can also differ in length. As a result, the program must be tailored to the environment in which it is utilized.

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APPENDICES

Appendix A: Feasibility Study

Table 3. Feasibility Study

Components	Price (NPR)
Arduino Uno	1100
Buzzer	99
Jumper wire	130
Camera Module	1199

The above table shows the price of the different hardware components that is used in this project.

Appendix B: Document Conventions

Margin and padding

Top: 1 inch

Bottom: 1 inch

Right:1 inch

Left: 1.5 inch

The font used in this document is as below;

Heading 1:

Font: Arial Bold Center Font size: 16 Text color: Purple

Heading 2:

Font: Arial Bold Font size: 14 Text color: Blue

Heading 3:

Font: Arial Font size: 12 Text color: Dark Blue

Normal text:

Heading 1:

Font: Arial Font size: 12 Text color: Black

Table Title:

Font: Arial Bold Center Font size: 12 Text color: Black

Table content:

Font: Arial Font size: 12 Text color: Green

Table and image captions:

Font: Arial Italic font size:10 Text color: Blue

Appendix C: Project Management

Meeting record sheet

School of Computing, Creative Technologies and Engineering 2020/21 Level 6 Production Project		
MEETING RECORD SHEET: 1		Meeting Number: 1
Student: Manis Chaudhary	Student I.D.: C7227167	
Date of Meeting: 24th Feb 2022	Supervisor: Mr. Suramya Sharma Dahal	
Actions agreed at the previous meeting (completed or comment):		
1	Setup Python	☐
2	Python installation Packages	☐
3	In-depth research on OpenCV	☐
4		☐
Comments of student (if any):		
ABOVE here – student to complete before Meeting with supervisor. BELOW here – complete at the Meeting.		
Next meeting (date/time):		
Agreed Actions to complete before next meeting:		
1	Research on TensorFlow	
2	Research on a machine learning algorithm	
3	Research on artificial Intelligence	
Comments of supervisor (if any):		

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School of Computing, Creative Technologies and Engineering 2020/21 Level 6 Production Project	
MEETING RECORD SHEET: 2	**Meeting Number: 2**
Student: Manis Chaudhary	**Student I.D.: C7227167**
Date of Meeting: 15th March 2022	**Supervisor: Mr. Suramya Sharma Dahal**

Actions agreed at the previous meeting (completed or comment):

1	Completed Research on TensorFlow	☐
2	Researched a machine learning algorithm	☐
3	Researched on artificial Intelligence	☐
4		☐

Comments ofstudentst (if any):

.....

ABOVE here – student to complete before Meeting with supervisor. ***BELOW here*** *– complete at the Meeting.*

Next meeting (date/time):

Agreed Actions to complete before next meeting:

1	Start face mask detection
2	Datasets for model training
3	Research on Deep Neural Network

Comments of supervisor (if any):

.....

.....

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School of Computing, Creative Technologies and Engineering 2020/21 Level 6 Production Project	
MEETING RECORD SHEET: 3	Meeting Number: 3
Student: Manis Chaudhary	Student I.D.: C7227167
Date of Meeting: 23th March 2022	Supervisor: Mr. Suramya Sharma Dahal

Actions agreed at the previous meeting (completed or comment):

1	Start face mask detection	☐
2	Face mask Datasets are collected	☐
3	Research on Deep Neural Network	☐
4		☐

Comments ofstudentst (if any):

.....

ABOVE here – student to complete before Meeting with supervisor. BELOW here – complete at the Meeting.

Next meeting (date/time):

Agreed Actions to complete before next meeting:

1	Datasets with masks and without a mask are trained
2	Model training
3	Finish Face Mask Detection

Comments of supervisor (if any):

.....

.....

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School of Computing, Creative Technologies and Engineering 2020/21 Level 6 Production Project	
MEETING RECORD SHEET: 4	Meeting Number: 4
Student: Manis Chaudhary	Student I.D.: C7227167
Date of Meeting: 1st April 2022	Supervisor: Mr. Suramya Sharma Dahal

Actions agreed at the previous meeting (completed or comment):

1	Datasets with masks and without a mask are trained	☐
2	Model training	☐
3	Finish Face Mask Detection	☐
4		☐

Comments of students (if any):

.....

ABOVE here – student to complete before Meeting with supervisor. BELOW here – complete at the Meeting.

Next meeting (date/time):

Agreed Actions to complete before next meeting:

1	Research about Social distance estimation
2	Research about Mobile Net-SSD
3	Start Social distance estimation

Comments of supervisor (if any):

.....

.....

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School of Computing, Creative Technologies and Engineering 2020/21 Level 6 Production Project	
MEETING RECORD SHEET: 5	Meeting Number: 5
Student: Manis Chaudhary	Student I.D.: C7227167
Date of Meeting: 4st April 2022	Supervisor: Mr. Suramya Sharma Dahal

Actions agreed at the previous meeting (completed or comment):

1	Researched about Social distance estimation	☐
2	Research about Mobile Net-SSD	☐
3	Start Social distance estimation	☐

Comments of students (if any):

.....

ABOVE here – student to complete before Meeting with supervisor. BELOW here – complete at the Meeting.

Next meeting (date/time):

Agreed Actions to complete before next meeting:

1	Review Social distancing estimation and face mask detection
2	Correct all occurred the errors
3	Start Literature review

Comments of supervisor (if any):

.....

.....

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School of Computing, Creative Technologies and Engineering 2020/21 Level 6 Production Project	
MEETING RECORD SHEET: 7	Meeting Number: 7
Student: Manis Chaudhary	Student I.D.: C7227167
Date of Meeting:24st April 2022	Supervisor: Mr. Suramya Sharma Dahal

Actions agreed at the previous meeting (completed or comment):

1	Review Social distancing estimation and face mask detection	☐
2	Corrected all occurred the errors	☐
3	Start Literature review	☐

Comments of students (if any):

.....

ABOVE here – student to complete before Meeting with supervisor. BELOW here – complete at the Meeting.

Next meeting (date/time):

Agreed Actions to complete before next meeting:

1	Complete literature review
2	Research about embossed number plate detection
3	Research about Arduino

Comments of supervisor (if any):

.....

.....

The British College

School of Computing, Creative Technologies and Engineering 2020/21 Level 6 Production Project	
MEETING RECORD SHEET: 8	Meeting Number: 8
Student: Manis Chaudhary	Student I.D.: C7227167
Date of Meeting:31st May 2022	Supervisor: Mr. Suramya Sharma Dahal
Actions agreed at the previous meeting (completed or comment):	
1	Completed all the requirement ☐
2	Submitted product along with the user guidelines and installation guidelines ☐
3	Completed presentation slides ☐
Comments of students (if any):	
ABOVE here – student to complete before Meeting with supervisor. ***BELOW here*** *– complete at the Meeting.*	
Next meeting (date/time):	
Agreed Actions to complete before next meeting:	
1	Completed Project
2	
3	
Comments of supervisor (if any):	

Figure 39. Meeting Record Sheet

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Appendix D: Ethical Consent Form

LEEDS BECKETT UNIVERSITY

STAGE 1 - RESEARCH ETHICS APPROVAL FORM

Research by students and staff at the University must receive ethical approval before any data collection commences. Applications may be made on the Research Ethics Online system or via approval forms.

If using the approval forms, applicants complete this Stage 1 - Research Ethics Approval Form which includes the Risk Checklist.

For student projects classified as Risk Category 1 (e.g., many literature reviews), these can be approved on this Stage 1 – Research Ethics Approval Form by the Research Supervisor.

Applicants whose research studies are classified as Risk Category 2 or 3 must also complete and submit the separate Stage 2 - Research Ethics Approval Form.

Guidance for completion of this form and the application process is provided on pages 3 and 4.

APPLICANT DETAILS	
Your name (if a group project, include all names)	Manis Chaudhary
School	The British College
STATUS	
• Undergraduate student	☒
• Taught Postgraduate student	☐
• Research Postgraduate student	☐
• Staff member	☐
• Other (give details)	
IF THIS IS A STUDENT PROJECT	
• Student ID	C7227167
• Course title (eg. BA (Hons) History)	BSc (Hons) Computing
• Student email	chaudharymanis921337@gmail.com
• Research Supervisor's name Or Director of Studies' name	Suramya Sharma Dahal
THE PROJECT/STUDY	
Project /study title	Smart COVID Violation Detector
Start date of the project	19-01-2022
Expected completion date of the project	9-02-2022
Project summary – please give a summary of your study (maximum 100 words)	
The goal of the project is to develop a software-based solution for COVID rule violations. The final product is solely based on several elements such as mask detections, a social distance violation analyzer, and a machine learning-based recognition system for odd-even number plates on automobiles. This concept focuses on using various analysis techniques to control COVID spread in the masses.	

CONFIRMATION STATEMENTS	
The results of research should benefit society directly or by generally improving knowledge and understanding. Please tick this box to confirm that your research study has a potential benefit. *If you cannot identify a benefit you must discuss your project with your Research Supervisor to help identify one or adapt your proposal so the study will have an identifiable benefit.*	☒
Please tick this box to confirm you have read the Research Ethics Policy and the relevant sections of the Research Ethics Procedures and will adhere to these in the conduct of this project.	☒

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RISK CHECKLIST - Please answer ALL the questions in each of the sections below – tick YES or NO WILL YOUR RESEARCH STUDY……..?		YES	NO
1	Involve direct and/or indirect contact with human participants?	☐	☒
2	Involve analysis of pre-existing data which contains personal or sensitive information, not in the public domain?	☐	☒
3	Require permission or consent to conduct?	☐	☒
4	Require permission or consent to publish?	☐	☒
5	Have a risk of compromising confidentiality?	☐	☒
6	Have a risk of compromising anonymity?	☐	☒
7	Collect/contain sensitive personal data?	☐	☒
8	Contain elements that you OR your supervisor are NOT trained to conduct?	☐	☒
9	Use any information OTHER than that which is freely available in the public domain?	☐	☒
10	Involve respondents to the internet or other visual/vocal methods where participants may be identified?	☐	☒
11	Include a financial incentive to participate in the research?	☐	☒
12	Involve your students, colleagues, or employees?	☐	☒
13	Take place outside of the country where you are enrolled as a student, or for staff, outside of the UK?	☐	☒
14	Involve participants who are particularly vulnerable or at risk?	☐	☒
15	Involve any participants who are unable to give informed consent?	☐	☒
16	Involve data collection taking place BEFORE informed consent is given?	☐	☒
17	Involve any deliberate deception or covert data collection?	☐	☒
18	Involve a risk to the researcher or participants beyond that experienced in everyday life?	☐	☒
19	Cause (or could cause) physical or psychological harm or negative consequences?	☐	☒
20	Use intrusive or invasive procedures?	☐	☒
21	Involve a clinical trial?	☐	☒
22	Involve the possibility of incidental findings related to health status?	☐	☒
23	Fit into any of the following security-sensitive categories: concerns terrorist or extreme groups; commissioned by the military; commissioned under an EU security call; involves the acquisition of security clearances? If yes, see the guidance.	☐	☒

CLASSIFICATION **The following guidance will help classify the risk level of your study**	Tick the box which applies to your project
If you answered **NO** to all the above questions, your study is provisionally classified as **Risk Category 1** (literature reviews will be Risk Category 1).	☒
If you answered **YES** to any question from 1-13 and **NO** to all questions 14-22, your study is provisionally classified as **Risk Category 2**.	☐
If you answered **YES** to any question from 14-22, your study is provisionally classified as **Risk Category 3**.	☐
If question 23 has been answered **YES**, your application will be reviewed by the Chair of the University Research Ethics Sub-committee	☐

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DECLARATION AND SIGNATURE/S			
I confirm that I will undertake this project as detailed above. I understand that I must abide by the terms of the approval and that I may not make any substantial amendments to the project without further approval.			
Signed		*Date*	27-02-2022

FOR RISK CATEGORY 1 STUDENT PROJECTS					
Approval from the Research Supervisor or Director of Studies for a student project: *I have discussed the ethical issues arising from the project with the student. I approve of this project.*					
Name	Suramya Sharma Dahal	*Signed*	Suramya Sharma Dahal	*Date*	27-02-2022

NEXT STEP

RISK CATEGORY 1 PROJECTS: IF YOUR PROJECT HAS BEEN CLASSIFIED AS RISK CATEGORY 1:

- Students: The Research Supervisor should return the signed form to the student and send a copy to the Local Research Ethics Co-ordinator and where relevant, the Research Module Leader, for information.
- Staff: Submit this form to your Local Research Ethics Co-ordinator.

RISK CATEGORY 2 OR 3 PROJECTS: IF YOUR PROJECT HAS BEEN CLASSIFIED AS RISK CATEGORY 2 OR 3 please complete Stage 2 - Research Ethics Approval form and submit both forms together with supporting documentation.

QUESTION 23: If this question has been answered **YES**, your application will be reviewed by the Chair of the University Research Ethics Sub-committee, and the forms should be submitted directly to Professor Karl Spracklen, k.spracklen@leedsbeckett.ac.uk. You will need to submit the Security-sensitive research form available on the Research Ethics web page.

Research ethics application forms will be retained in the School for the purposes of quality assurance of compliance and audit for THREE years

NOTES FOR COMPLETION

University Research Ethics Policy and Procedures: The University Research Ethics Policy and Research Ethics Procedures should be read before commencing this application. Consideration of the application by the reviewer/s will be undertaken by the Policy and Procedures.

External requirements for the project: Applicants should consider if there are requirements by any relevant professional, statutory or regulatory body, or learned society, which may be relevant to the project or if the project also requires external approval.

Submission

- Student applicants: email the typed form/s to your Research Supervisor or Director of Studies.
- Staff applicants: email the typed form/s to your Local Research Ethics Co-ordinator.

How to complete the form

You can navigate through the form by using the tab keys. If you prefer to complete a normal Word document, you can unlock the form by selecting the 'Restrict Editing' button on the Developer tab, then clicking on 'Stop Protection'. The boxes should expand to allow space for your text.

Signatures
Electronic/typed signatures are acceptable for emailed forms, as the emails provide the audit trail for all parties' agreement and approval of the forms (e.g., student applicant →Research Supervisor →Local Research Ethics Co-ordinator).

Outcome
Applicants will be advised of the outcome of the application by receipt of the signed form from:

- The Research Supervisor or Director of Studies for Risk Category 1 student projects;
- The Local Research Ethics Co-ordinator or the School level group for Risk Category 2 and 3 projects.

YOU MAY ONLY BEGIN ANY DATA COLLECTION ONCE YOU RECEIVE NOTIFICATION THAT THE PROJECT HAS ETHICAL APPROVAL. If the circumstances of your research study change after approval it is your responsibility to revisit the Risk Checklist and complete a further application.

Advice
When completing Stage 1 - Research Ethics Approval Form, if you are uncertain about the answer to any question, read the relevant section of the Research Ethics Procedures document, and if you are still unsure:

- if you are a student, seek guidance from your Research Supervisor or Director of Studies;
- if you are a staff member, contact your Local Research Ethics Co-ordinator.

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APPROVAL PROCESS

- Local Research Ethics Co-ordinator = LREC
- School-level group (if your School uses a different review process, please follow your School guidance)
- University Research Ethics Sub-Committee = URESC

Category	Student applicants	Staff applicants
Risk Category 1	If your study has been provisionally classified as Risk Category 1, your Research Supervisor (or Director of Studies) can normally approve the project. You must complete this form and submit it to your Research Supervisor for consideration. A copy of the signed form if approved must be given or emailed to the LREC and, where relevant, the Research Module Leader, for information.	If your study has been classified as Risk Category 1, you do not need ethical approval for the project. You must complete the remainder of this form so that your research project is registered with the University. Please submit this form to your LREC.
Risk Category 2	If your study has been provisionally classified as Risk Category 2, your Supervisor (or Director of Studies) can recommend approval for your study by the LREC. You must complete this application form and also the separate Stage 2 - Research Ethics Approval form. Once you have completed the forms please submit both forms and supporting documentation to your Research Supervisor for consideration. Your Supervisor may disagree with your assessment and ask you to make revisions or reject your application. When the Research Supervisor is happy to recommend the application for approval, they will send the forms to the LREC. The LREC will review your project and then decide to approve it, ask for revisions, reject it, or pass it on for review by the School level group.	If your study has been provisionally classified as Risk Category 2, your project will be considered for ethical approval by the LREC. You must complete this application form and also the separate Stage 2 - Research Ethics Approval form. Please submit both forms and supporting documentation to your LREC for consideration. The LREC will review your project and then decide to approve it, ask for revisions or pass it on for review by the School level group.
Risk Category 3	**Postgraduate Research Students** If your study has been provisionally classified as Risk Category 3, your Supervisor or Director of Studies can recommend approval for your study by the LREC. You must complete this application form and also the separate Stage 2 - Research Ethics Approval form and submit both forms to your Director of Studies. If your Director of Studies recommends approval of your project they will refer it to the LREC who will review your project and decide whether to grant ethical approval, request revisions, reject the application, or refer it to the School level group for review. **Undergraduate and Taught Postgraduate Students** If your study has been provisionally classified as Risk Category 3, you should consult with your Research Supervisor immediately as it is unlikely you will be able to proceed and you should negotiate a project that is of lower risk. However, if you have already discussed the project with your Supervisor and they have agreed that a case for approval is warranted, proceed in line with the details above for Research Students.	If your study has been provisionally classified as Risk Category 3, your project will be considered for ethical approval by an appropriate LREC. You must complete this application form and also the separate Stage 2 - Research Ethics Approval form and submit both forms with supporting documentation to your LREC. The LREC will review your project and then decide to approve it, ask for revisions or pass it on for review by the School level group.
Q23	If question 23 has been answered 'yes', your application will be reviewed by the Chair of the University Research Ethics Sub-committee. The answer does not affect the Risk Category.	

Figure 40. Ethical Consent Form

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Appendix E: Source Code of the implementation

Face Mask Detection

```
from tensorflow.keras.preprocessing.image import img_to_array
from tensorflow.keras.models import load_model
import numpy as np
import cv2
import os
from imutils.video import VideoStream
import imutils
from serial import Serial

port = 'COM3'
baudRate = 9600

ser = Serial(
    port=port,
    baudrate=baudRate
)

def detect_and_predict_mask(frame,faceNet,maskNet):
    #grab the dimensions of the frame and then construct a blob
    (h,w)=frame.shape[:2]
    blob=cv2.dnn.blobFromImage(frame,1.0,(300,300),(104.0,177.0,123.0))

    faceNet.setInput(blob)
    detections=faceNet.forward()
```

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```
#initialize our list of faces, their corresponding locations and list of predictions

faces=[]
locs=[]
preds=[]


for i in range(0,detections.shape[2]):
    confidence=detections[0,0,i,2]


    if confidence>0.5:
    #we need the X,Y coordinates
        box=detections[0,0,i,3:7]*np.array([w,h,w,h])
        (startX,startY,endX,endY)=box.astype('int')

        #ensure the bounding boxes fall within the dimensions of the frame
        (startX,startY)=(max(0,startX),max(0,startY))
        (endX,endY)=(min(w-1,endX), min(h-1,endY))

        #extract the face ROI, convert it from BGR to RGB channel, resize it to
224,224 and preprocess it
        face=frame[startY:endY, startX:endX]
        face=cv2.cvtColor(face,cv2.COLOR_BGR2RGB)
        face=cv2.resize(face,(300,300))
        face=img_to_array(face)
        #face=preprocess_input(face)
```

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```
            faces.append(face)
            locs.append((startX,startY,endX,endY))

        #only make a predictions if atleast one face was detected
        if len(faces)>0:
            faces=np.array(faces,dtype='float32')
            preds=maskNet.predict(faces,batch_size=12)
        return (locs,preds)



prototxt = r'./deploy.prototxt'

weights_path = r'./SSD.caffemodel'

faceNet=cv2.dnn.readNet(prototxt,weights_path)


maskNet = load_model(r'./new_improved_model.h5')


vs=VideoStream(src=0).start()

while True:
    #grab the frame from the threaded video stream and resize it
    #to have a maximum width of 400 pixels
    frame=vs.read()
    frame=imutils.resize(frame,width=400)
```

The British College

```
    #detect faces in the frame and preict if they are waring masks or not
    (locs,preds)=detect_and_predict_mask(frame,faceNet,maskNet)

    #loop over the detected face locations and their corrosponding loactions

    for (box,pred) in zip(locs,preds):
        (startX,startY,endX,endY)=box
        #(mask,withoutMask)=pred

        #determine the class label and color we will use to draw the bounding box
and text
        label='Mask' if pred==0 else 'No Mask'
        color=(0,255,0) if label=='Mask' else (0,0,255)

        if pred != 0:
            ser.write(b"1\r\n")
        else:
            ser.write(b"2\r\n")
        #display the label and bounding boxes
        cv2.putText(frame,label,(startX,startY-
10),cv2.FONT_HERSHEY_SIMPLEX,0.45,color,2)

        cv2.rectangle(frame,(startX,startY),(endX,endY),color,2)

    #show the output frame
    cv2.imshow("Frame",frame)
    key=cv2.waitKey(1) & 0xFF
```

```
if key==ord('q'):
    ser.write(b"2\r\n")
    break

cv2.destroyAllWindows()
vs.stop()
ser.close()
```

Face mask detection model training code

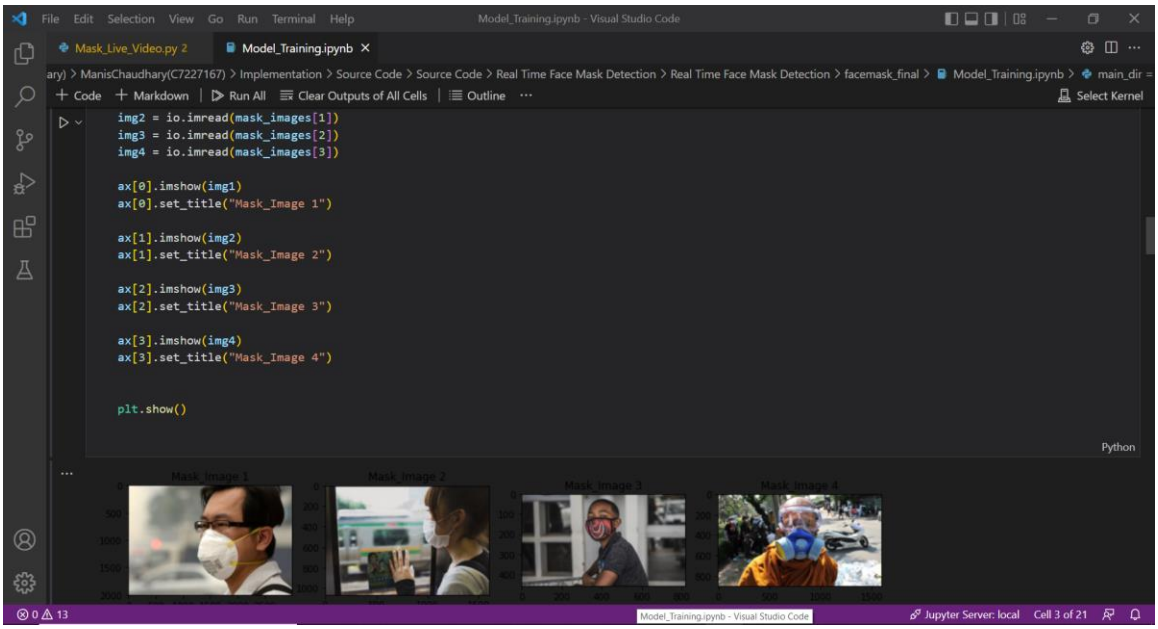

Figure 41. Datasets Training

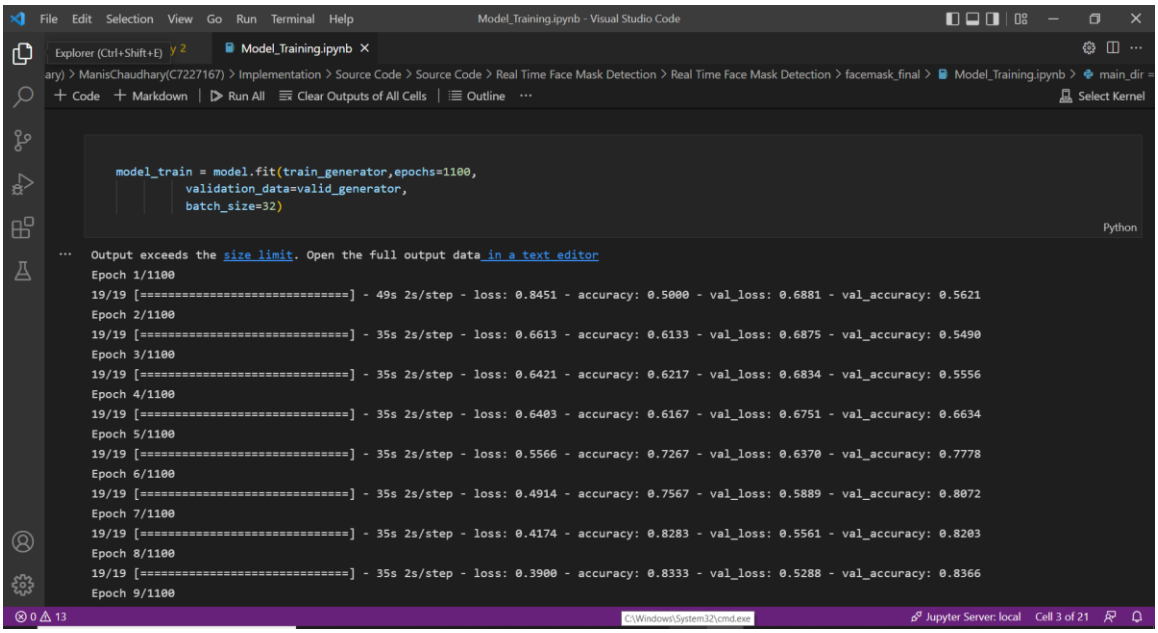

Figure 42. Model Training

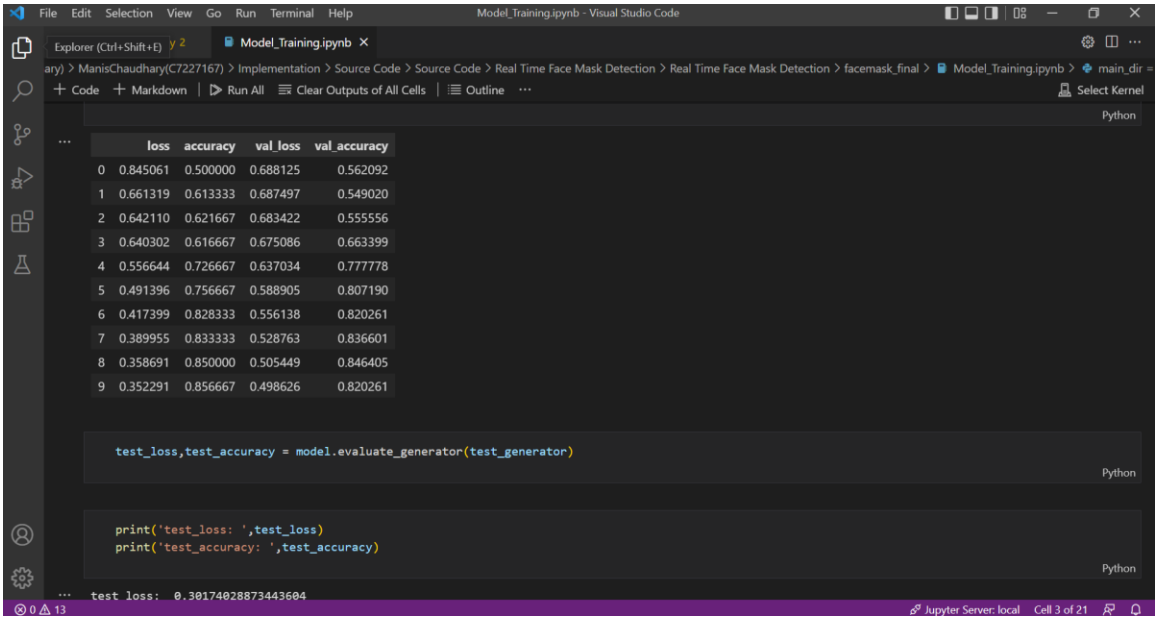

Figure 43. . Model Training Accuracy after Model Training

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Social Distance Estimation Code

```
import cv2
import numpy as np
from math import pow, sqrt
from serial import Serial

#Constant Values
preprocessing = False
calculateConstant_x = 300
calculateConstant_y = 615
personLabelID = 15.00
debug = True
accuracyThreshold = 0.4
RED = (0,0,255)
YELLOW = (0,255,255)
GREEN = (0,255,0)
write_video = False

port = 'COM3'
baudRate = 9600

ser = Serial(
    port=port,
    baudrate=baudRate
)

# I used CLAHE preprocessing algorithm for detect humans better.
# HSV (Hue, Saturation, and Value channel). CLAHE uses value channel.
```

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```
            elif distanceOfBboxes < 200 > 150: # between 150 and 200
                mediumRisk.add(i),mediumRisk.add(j)


    cv2.putText(frame, "Person in High Risk : " + str(len(highRisk)) , (20, 20),
cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255), 2)
    cv2.putText(frame, "Person in Medium Risk : " + str(len(mediumRisk)) , (20,
40), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 255), 2)
    cv2.putText(frame, "Detected Person : " + str(len(detectionCoordinates)),
(20, 60), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)

    drawResult(frame, position)
    if write_video:
        output_movie.write(frame)
    cv2.imshow('Result', frame)
    waitkey = cv2.waitKey(1)
    if waitkey == ord("q"):
        ser.write(b"2\r\n")
        break

cap.release()
cv2.destroyAllWindows()
ser.close()
```

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```
            # Default drawing bounding box.
            bboxDefaultColor = (255,255,255)
            cv2.rectangle(frame, (startX, startY), (endX, endY),
bboxDefaultColor, 2)
            detectionCoordinates[i] = (startX, startY, endX, endY)

            # Centroid of bounding boxes
            centroid_x, centroid_y, bboxHeight =
centroid(startX,endX,startY,endY)
            distance = calcDistance(bboxHeight)
            # Centroid in centimeter distance
            centroid_x_centimeters = (centroid_x * distance) /
calculateConstant_y
            centroid_y_centimeters = (centroid_y * distance) /
calculateConstant_y
            position[i] = (centroid_x_centimeters, centroid_y_centimeters,
distance)

    #Risk Counter Using Distance of Positions
    for i in position.keys():
        for j in position.keys():
            if i < j:
                distanceOfBboxes = sqrt(pow(position[i][0]-position[j][0],2)
                                + pow(position[i][1]-position[j][1],2)
                                + pow(position[i][2]-position[j][2],2)
                                )
                if distanceOfBboxes < 150: # 150cm or lower
                    highRisk.add(i),highRisk.add(j)
```

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```
    position = dict()
    detectionCoordinates = dict()

    if not debug_frame:
        print("Video cannot opened or finished!")
        break

    if preprocessing:
        frame = CLAHE(frame)

    (imageHeight, imageWidth) = frame.shape[:2]
    pDetection = cv2.dnn.blobFromImage(cv2.resize(frame, (imageWidth,
imageHeight)), 0.007843, (imageWidth, imageHeight), 127.5)

    caffeNetwork.setInput(pDetection)
    detections = caffeNetwork.forward()

    for i in range(detections.shape[2]):

        accuracy = detections[0, 0, i, 2]
        if accuracy > accuracyThreshold:
            # Detection class and detection box coordinates.
            idOfClasses = int(detections[0, 0, i, 1])
            box = detections[0, 0, i, 3:7] * np.array([imageWidth, imageHeight,
imageWidth, imageHeight])
            (startX, startY, endX, endY) = box.astype('int')

            if idOfClasses == personLabelID:
```

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```
        else:
            rectangleColor = GREEN
            ser.write(b"2\r\n")
        (startX, startY, endX, endY) = detectionCoordinates[i]

        cv2.rectangle(frame, (startX, startY), (endX, endY), rectangleColor, 2)


if __name__== "__main__":

    caffeNetwork = cv2.dnn.readNetFromCaffe("./SSD_MobileNet_prototxt.txt",
"./SSD_MobileNet.caffemodel")
    # For video File
    # pass 0 or integer for camera input
    #cap = cv2.VideoCapture('pedestrians.mp4')

    cap = cv2.VideoCapture(0)

    fourcc = cv2.VideoWriter_fourcc(*"XVID")
    output_movie = cv2.VideoWriter("./result.avi", fourcc, 24,
(int(cap.get(cv2.CAP_PROP_FRAME_WIDTH)),
int(cap.get(cv2.CAP_PROP_FRAME_HEIGHT))))


    while cap.isOpened():

        debug_frame, frame = cap.read()
        highRisk = set()
        mediumRisk = set()
```

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```
# Value channel refers to the lightness or darkness of a colour. An image without
hue or saturation is a grayscale image.
def CLAHE(bgr_image: np.array) -> np.array:
    hsv = cv2.cvtColor(bgr_image, cv2.COLOR_BGR2HSV)
    hsv_planes = cv2.split(hsv)
    clahe = cv2.createCLAHE(clipLimit=2.0, tileGridSize=(8, 8))
    hsv_planes[2] = clahe.apply(hsv_planes[2])
    hsv = cv2.merge(hsv_planes)
    return cv2.cvtColor(hsv, cv2.COLOR_HSV2BGR)

def centroid(startX,endX,startY,endY):
    centroid_x = round((startX+endX)/2,4)
    centroid_y = round((startY+endY)/2,4)
    bboxHeight = round(endY-startY,4)
    return centroid_x,centroid_y,bboxHeight

def calcDistance(bboxHeight):
    distance = (calculateConstant_x * calculateConstant_y) / bboxHeight
    return distance

def drawResult(frame,position):
    for i in position.keys():
        if i in highRisk:
            rectangleColor = RED
            ser.write(b"1\r\n")
        elif i in mediumRisk:
            rectangleColor = YELLOW
            ser.write(b"1\r\n")
```

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Automatic Number Plate Detection Code

```
    iteration += 1
    originimage = cv2.imread(imagePath)
    image = imutils.resize(originimage, width=400, height=400)

    image = cv2.bilateralFilter(image, 3, 105, 105)
    anpr.debug_imshow("Bilateral Filter", image, waitKey=True)

    (lpText, lpCnt) = anpr.find_and_ocr(iteration, image, psm=args["psm"],
clearBorder=args["clear_border"] > 0)

    if lpText is not None and lpCnt is not None:
        box = cv2.boxPoints(cv2.minAreaRect(lpCnt))
        box = box.astype("int")
        cv2.drawContours(image, [box], -1, (0, 255, 0), 2)

        (x, y, w, h) = cv2.boundingRect(lpCnt)
        cv2.putText(image, cleanup_text(lpText), (x, y - 15),
            cv2.FONT_HERSHEY_SIMPLEX, 0.75, (0, 255, 0), 2)

        print("[INFO] Registration number: {}".format(lpText))
        anpr.debug_imshow("Output ANPR", image, waitKey=True)

    anpr.save_result("Final{}.jpg".format(iteration), image)
    cv2.destroyAllWindows()
```

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```
    help="Whether to save or not the results in a folder")
ap.add_argument("-m", "--morphology", type=str, default = 'bh',
    help="Whether to use black hat (-m bh) or top hat (-m th). Black hat is better at
detecting black-on-white license plate while top hat is the opposite.")
args = vars(ap.parse_args())

anpr = None
iteration = 0

input_dir = args["input"]
input_dir_name = input_dir.split('/')[-1]

algo = args["algorithm"]
if algo == 1:
    anpr = SobelANPR(algo, input_dir_name, morph=args["morphology"],
debug=args["debug"] > 0, save=args["save"] > 0)
elif algo == 2:
    anpr = CannyANPR(algo, input_dir_name, morph=args["morphology"],
debug=args["debug"] > 0, save=args["save"] > 0)
elif algo == 3:
    anpr = EdgelessANPR(algo, input_dir_name, morph=args["morphology"],
debug=args["debug"] > 0, save=args["save"] > 0)
else:
    print('Invalid algorithm choice')
    sys.exit()

imagePaths = sorted(list(paths.list_images(input_dir)))
for imagePath in imagePaths:
```

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```
from anprclass import CannyANPR, EdgelessANPR, SobelANPR
from imutils import paths
import argparse
import imutils
import sys
import cv2
import os

test = os.getcwd()
print(test)

def cleanup_text(text):
    return "".join([c if ord(c) < 128 else "" for c in text]).strip()

ap = argparse.ArgumentParser()
ap.add_argument("-i", "--input", required=True,
    help="Path to input directory of images")
ap.add_argument("-c", "--clear-border", type=int, default=-1,
    help="Whether or to clear border pixels before OCR'ing")
ap.add_argument("-p", "--psm", type=int, default=7,
    help="Default PSM mode for OCR'ing license plates")
ap.add_argument("-d", "--debug", type=int, default=-1,
    help="Whether or not to show additional visualizations")
ap.add_argument("-a", "--algorithm", type=int, default=1,
    help="Choose an edge detection method (1 - Sobel edge detection, 2 - Canny
edge detection, 3 - Edge-less approach")
ap.add_argument("-s", "--save", type=int, default = -1,
```

Arduino Ide code for alert message system

buzzer | Arduino 1.8.19

File Edit Sketch Tools Help

buzzer

```
#define BUZZER 7
// 1 for buzz 2 for none
int serialData = 0;

void setup() {
  // put your setup code here, to run once:
  pinMode(BUZZER, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  // put your main code here, to run repeatedly:
  if(Serial.available())
  {
    serialData = Serial.parseInt();
    Serial.println(serialData);
  }
  if(serialData == 1){
  tone(BUZZER, 200);
  }
  else if (serialData == 2)
  {
    noTone(BUZZER);
  }
}
```

Figure 44. Message Alert System Code

Appendix F: User Guidelines

Real Time Face Mask Detection Use Case Diagram

4) User's face must be put in front of the camera where the background light should be managed.
5) Camera will detect the user's face with or without the mask-wearing on the face by the green box and red box respectively.

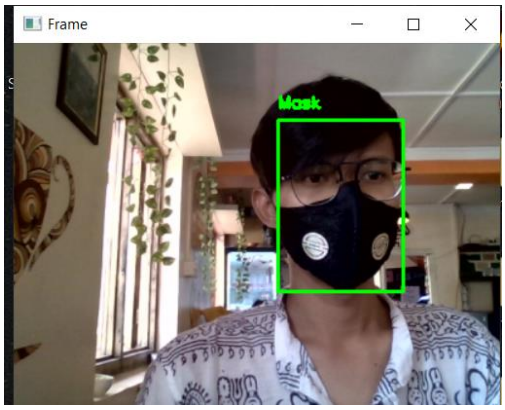

Figure 45. Detect the user's face with a mask

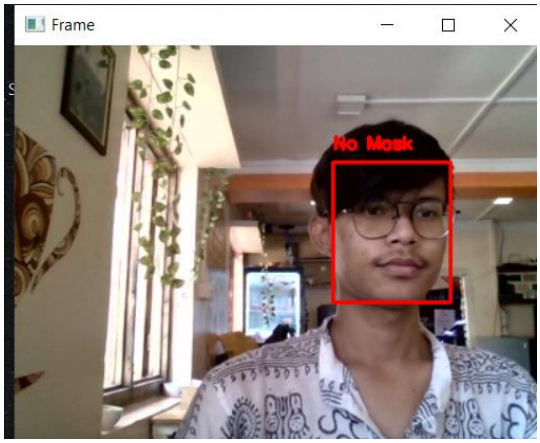

Figure 46. Detect face without a mask

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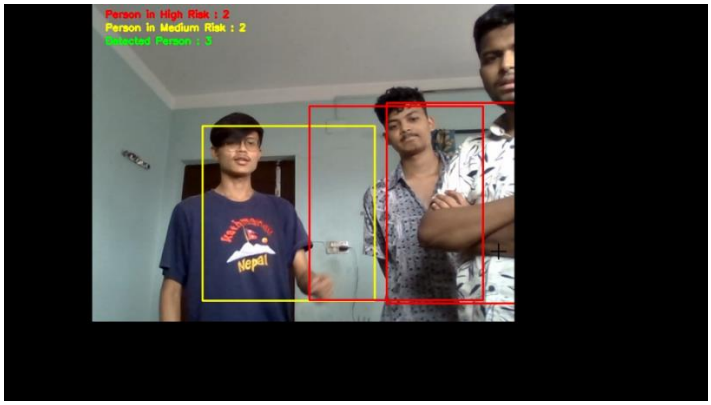
Social Distancing Estimation Use Case Diagram

2) Camera module within the organization estimates the social distance between people. Which are given below;
   If the distance between two people is 150 or less than 150 cm then it will show high risk and the system will alert them.

Similarly, If the distance between two people is between 150 – 200 cm then it will show a medium risk and the system will alert them.



Otherwise, it will not show any risk.

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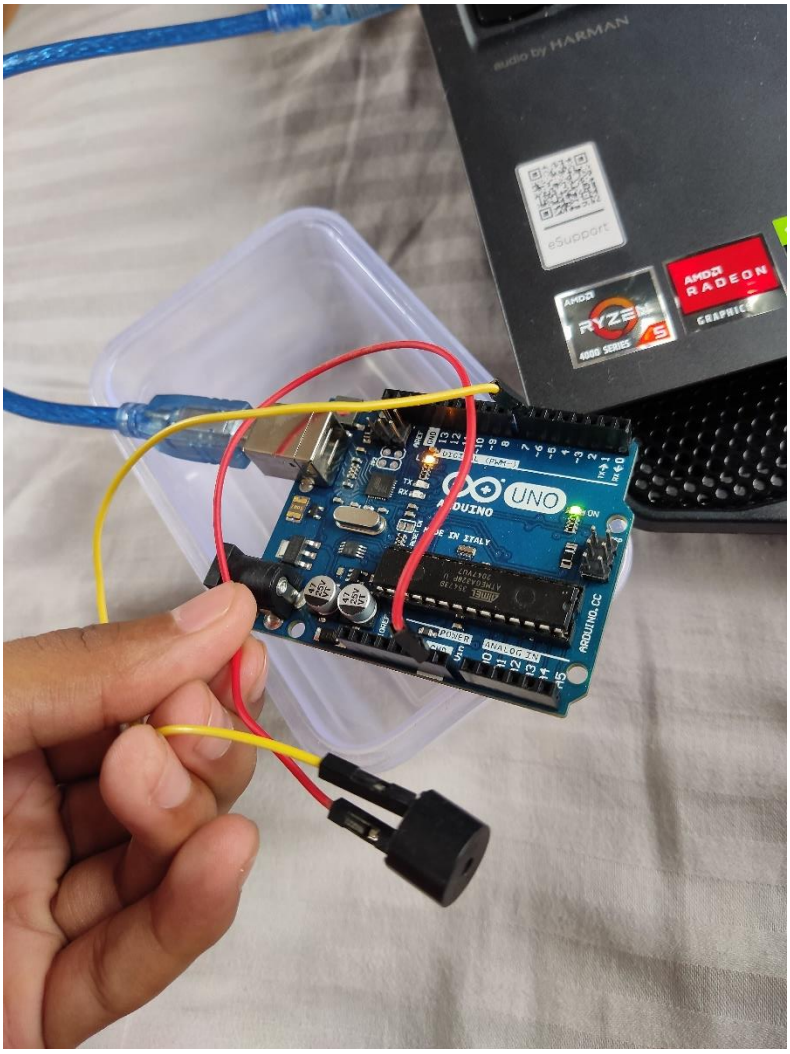
Automatic Odd-Even Number Plate Detection Use Case Diagram

3) Vehicle image will capture from the camera module within a certain distance of the system.

4) Image will process into the module and detect the number plate.

```
./result_sobel_overseas
./result_sobel_overseas
[INFO] Registration number: MH20EE7601
```

2) Buzzer Will play with the help of Arduino if anyone violates the rule. For example, if anyone is in front of the camera buzzer will play.



Appendix G: Git Hub Link

https://github.com/manischaudhary/Smart-COVID-Violation-Detector