Coherence: A Scientific Journal
A Peer- Reviewed Journal of the Science Section
The Bhawanipur Education Society College
Vol.1, Issue 1 (2022) 30-40

Use of Computer Vision for Face Mask Detection

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Abstract

The most deadly disease of the past hundred years is the novel corona virus that spreads across the globe very rapidly. It is proven that the disease is a droplet borne one, hence to reduce the rate of growth of the epidemic people must cover their mouth and nose with a mask in any sort of social gatherings or public places. We have designed a computer vision based system that is capable to detect whether a person is wearing mask or not. We have used OpenCV library to study the image. The OpenCV library has got a set of public domain classifiers to detect face; these classifiers have been used to test various conditions coupled with different data but it has not been used to detect presence of mask. In our framework the computer is able to detect any sort of masks on any human face. We have implemented a dataset in our framework with 94% of accuracy.

Keywords: COVID-19, Computer Vision, Open CV, face-recognition, Open-Vino.

1. Introduction

Face recognition [1] is an AI based technology that is a branch of image processing that helps to determine the size, shape, orientation and other details from human face. It is used to detect the faces from any digital image. Human brain has thousands of neurones and with the help of those neural networks an individual can recognise any person by looking at the image. Computer Vision [2] is the subdivision of computer science where such networks are designed artificially to detect or analyse any known or unknown data coming to it. For the past two or three decades computer vision has become a major research field for many that enables us to detect any objects or solve many problems without human supervision. Since the past century, the most deadly virus is the novel corona virus that is spreading worldwide, claiming lives of millions across the globe [3]. The World Health Organisation has studied this issue and proposed that the virus spreads through respiratory droplets from cough or sneeze [4]. The disease is spreading almost exponentially and in many places the number of affected people is very large compared to the number of hospital beds [5]. This compelled different nations to commit lockdown by compromising their overall economy. However, in many countries the lockdown has been relaxed [6] so that normal routine can be initiated; therefore it is advised to wear face masks in public places or in any sort of gatherings. Hence we have developed a system using OpenCV [7] platform that would detect presence or absence of mask in any individual from digital image. Section 2 explains the background of this pandemic and need for wearing mask, we have explained the basic concepts of Computer Vision and OpenCV library in Section 3; in Section 4 we have reviewed some pre-existing

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face recognition frameworks, we have explained our framework in section 5 and showed our result in Section 6. Some future directions of this research have been given in the Section 7 and finally, Section 8 concludes the paper.

2. Background

In December, 2019 the novel corona virus (COVID-19) was first detected in the Wuhan Province or Central China [8]. After the detection of the first case, it was reported to WHO and on January 30, 2020 WHO declared COVID-19 as a global public threat [9]. The virus that results to COVID-19 is called "Severe Acute Respiratory Syndrome Corona Virus-2" or SARS-CoV-2 [8]. Corona is a group of viruses that results in diseases like simple cough and cold; a few other corona viruses that affected human beings in the current past are "Middle East Respiratory Syndrome Corona Virus" or MERS-CoV and "Severe Acute Respiratory Syndrome Corona Virus" or SARS-CoV [10]. The sickness COVID-19 is caused from a comparable virus SARS-Cov-2; it was not seen in human beings earlier. According to the WHO reports, it is assumed that the virus is zoonotic; this is because the virus appeared due to contagion from animals to humans. It was predicted that this virus was contaminated from musk cats to human and the virus mutated fast to affect and reproduce in an alarming rate in human body. According to some people, the virus had originated from bats by the similar way. In about 82% of the cases COVID-19 the victims are asymptomatic, this is more dangerous since these people may spread the pathogen and affect others. On the other hand the lungs gets so affected that even death can occur [11].The epidemic is growing rapidly since the virus spreads by simple contact or through respiratory droplets from an individual to other [12], however these droplets are unable to travel more than 6 feet, hence social distancing is advised by experts along with that covering the face with mask is very essential in public places. COVID-19 is characterized by some symptoms like fever, cough and cold, sore throat, fatigue, headache, loss of smell and taste, diarrhea, respiratory problems like shortness of breath, chest pain, and dry cough and in some acute cases pneumonia may occur making some irreversible damage in lungs leading to multi-organ failure leading to death [13]. It has been observed that so far the mortality rate of this pandemic is around 3% world-wide, but since the virus spreads so rapidly covering the face in public gatherings is highly necessary [10]. Table 1 shows the family of corona viruses that affected human beings in the recent past.

Table 1: Family of corona virus

Corona Virus	Origin	Year	Death Rate
SARS	Guangdong Province, China	2002	10%
MERS	Saudi Arabia	2013	34%
SARS-Cov-2	Wuhan, China	2019	2-3%

According to the data till July 7th, 2020, COVID-19 has affected over 11,500,000 people globally and killing more than 530,000 individuals. More than 180 countries, almost all continents apart from Antarctica became victims of COVID-19. On March 11, 2020 COVID-19 was declared as a global pandemic by the WHO [14]. Figure 1 shows the confirmed cases of COVID-19 for the top 10 countries.

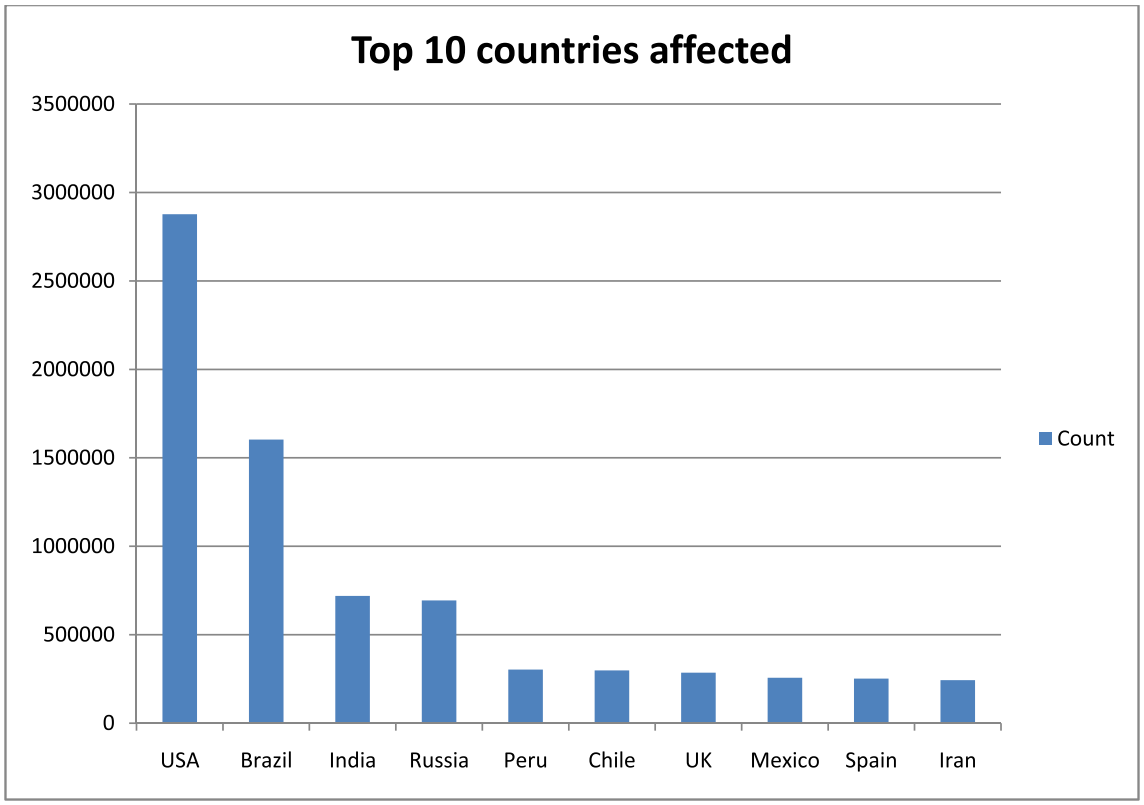

Figure 1. Number of person affected due to COVID-19 *(Source: WHO website updated upto 7th July, 2020)*

3. Basics of Computer Vision in Face Recognition

It is basically a branch of AI that is capable of training computers so that they can be used to interpret and detect the data given to a computer [2]. In other words, machine learning is a subfield of AI. The same way that a human being is able to recognise any object with the assistance of thousands of neurones in the brain, the same way that computers are able to recognise or analyse any data that is given to it by proper classification can be accomplished by developing a system of such artificial neural networks. It is a fruitful area of research that encourages a large number of people to find solutions to a variety of issues without the assistance of humans. It is a multidisciplinary field that focuses on the analysis of digital data such as pictures, videos, and many other types of information. When it comes to image processing, computer vision has a significant impact on the ability to categorise various images in the same way that a human brain does. It requires the use of multiple algorithms to train on previously known data in order to be able to analyse previously unknown data. When it comes to face recognition, computer vision is a very helpful tool that can count the number of people in any image or video as well as identify the face of any person from a digital image by ignoring the background. Additionally, it can be used to identify faces of any person in the image or video. Image processing is a subfield of computer vision that employs a number of different algorithms in order to analyse and categorise any digital image in the same manner that a person would.

How a computer recognises faces are extensively analysed by Sinha P and et al in their research. The primary objective of computer vision is to generate an autonomous face recogniser system that can serve

as a better alternative as compared to a human brain. The way human beings recognises faces, the authors have made their framework and obtained 19 basic results [15].

It is needless to say that the computer scientists have worked on the matter to develop an autonomous face recogniser in social media so that automated tagging can be done. This is primarily based on how nerve cells act when a human being recognises objects. The biologically inspired modelling of computer vision based framework was proven to be a bench mark in the domain of unconstrained face recogniser in facebook platform [16].

Some challenges of face recognition using automated computers has been analysed by Hassaballah M, et al. that includes Illumination variations, Pose/viewpoint, age, style, expression [17].

Recognition of faces has gained a lot of focus in recent years due to its status as one of the most fruitful applications of image analysis and comprehension. This development can be attributed to at least two factors: (a) the numerous commercial and law enforcement uses for which this technology was developed, and (b) the advent, after 30 years of study, of technologies that are both practical and affordable. The restrictions imposed by many real-world applications mean that even while modern machine recognition systems have matured, they still have their limits. For instance, there is still more work to be done on the challenge of recognising faces in photographs shot outdoors, where factors like lighting and position may be constantly shifting. Simply said, present technology is light-years behind what the human perceptual system is capable of. In order to provide a thorough overview, Zhao. W and the coworkers have classified existing recognition methods and describe typical methods from each class in great detail. Additionally, issues of illumination and position variation, as well as psychophysical investigations, system evaluation, and other pertinent topics, are discussed [18].

OpenCV [7] is the acronym of Open Source Computer Vision Library. It is an open source library made by INTEL, developed by Willow Garage, it is a cross platform library mainly used in image detection using python. Because of its immense application value and market potential, face detection technology has gained a lot of attention in recent years. Some examples of this include face recognition and video surveillance systems. Real-time face detection is not just a component of an autonomous face recognition system, but it is also becoming its own independent area of research. Therefore, there are many different ways to handle the problem of face detection. This article presents a modified version of the AdaBoost algorithm that is based on OpenCV. Additionally, tests of real-time face detection using two different approaches, namely timer and dual-thread, are provided. The findings indicate that the face identification method using dual-thread is not only easier but also smoother and more accurate [19].

We have implemented a framework to detect whether an individual has worn a mask or not.

4. Literature Survey

S. Emami, et al [20] has proposed a framework that makes an application that allows an individual user to access a particular person's facial features using OpenCV and Microsoft's .NET platform and obtained significantly good results.

K Kadir and et al [21] has studied two classifiers to detect face with accuracy, these are haar like features and LBP (Local Binary Pattern) features. The authors have studied the hit-rate of image detection and speed of the framework. The research was tested on Microsoft Visual C++ 2010 Express with OpenCV

library. K. Kadir and et al has determined that LBP classifier shows better efficiency and they are reliable in real-time face recognition.

M. Kalas [22] in her paper has reviewed three different algorithms for real-time face detection using OpenCV platform. She has used Haar cascade, adaboost, template matching to classify raw digital image data and also mentioned various applications of face recognition. It was stated by the author that none of the algorithms are best for face detection universally. According to the author, the main benefit of using Haar-like feature over most other features is because it is fast. At the same time Adaboost algorithms require training data and these are slower in terms of face recognition.

D. Pimplaskar and et al [23] has designed a framework using OpenCV library that can detect blinking of eye as well as position of eye with good accuracy from real-time video. The authors have used centroid method and connected component technique in their project.

M. Bansal [24] in his paper has implemented face recognition on Raspberry-Pi using OpenCV library in python. For face identification Bansal has used Haar-Cascades and Eigenfaces, Fisherfaces and Local double example histograms were used for face recognition. The author has used his code in Raspberry Pi for continuous recognition.

S. Khan and et al [25] has designed a model that can count attendance of people using face recognition technique using API and OpenCV platform. The authors have proposed a system that can be used to monitor attendance by using some object detection algorithms like back propagation neural network, region based convolution network (RCNN), faster RCNN, single shot detector. The research was carried out using YOLO V3 model for face detection and Microsoft Azure using face API for face recognition as a database for known faces. The authors have used YOLO V3 algorithm to count the candidates from a single image and that will generate a spreadsheet document with known and unknown faces that would be sent to the admin via email. The system works well in real time environment.

M. Khan and et al [26] has proposed a framework that can do face detection using openCV platform. The authors have used a statistical method known as PCA (Principal Component Analysis) for facial recognition. This tool reduces large amount of data storage. They have made a 1-D pixel vector from a 2-D digital image of face. They have used haar cascade, eigen-face, fisher-face, LBPH algorithms using OpenCV platform in python.

N. Boyoko and et al [22] has compared different face recognition tools based on OpenCV and Dlib libraries. The authors have studied the time complexity of the face recognition algorithms. The authors have chosen a couple of libraries they are Dlib and OpenCV and estimated benefits and shortcomings of both the libraries. The authors have implemented simple applications based on these libraries and compared their performances. OpenCV library has been proven to have better performance in the domain of face recognition and this could be advantageous to make IoT based recognition applications.

B. Mandal and et al [27] has presented a face recognition system (based on computer vision) on Google Glass in order to assist users in social interactions. The authors have used OpenCV platform to implement their framework. The authors have proposed a wearable system on Google glass for social interaction assistant. The model will at first take real time image by the Google Glass and followed by that face recognition will be performed on those images. The research was done using OpenCV and Integration of Sketch and Graph patterns to locate pair of eyes on the face. OpenCV works better in

vertical frontal view and the ISG works better in oblique views. The existing eigen-feature regularization and extraction approach for face recognition was modified by introduction of subclass discriminant analysis for facial feature extraction that eventually improves the accuracy of the model. This works in any lighting conditions and varying face poses. The researchers have also implemented user interface on the Google Glass and client server system via Bluetooth module to connect with smart-phone along with that care has been taken for data security. The system was tested and it showed 91% accuracy with 7 images can be stored in gallery database. The local standalone system took 7.49 seconds and Bluetooth based system took 0.33 seconds; in every recognitions.

5. Methodology

In order to optimize our model, and perform accurate segmentation problem, we use openvino toolkit [29] along with OpenCV library [30]. Our model has got a provision to detect face mask on an individual from both digital image and video. We have implemented the system in Python 3.6.5, using Pycharm [31]. We have used TensorFlow [32] as well that is an open source artificial intelligence library, which enables us to create large-scale multi-layered neural networks to classify the input image data. The flowchart to detect presence or absence of face mask is given below.

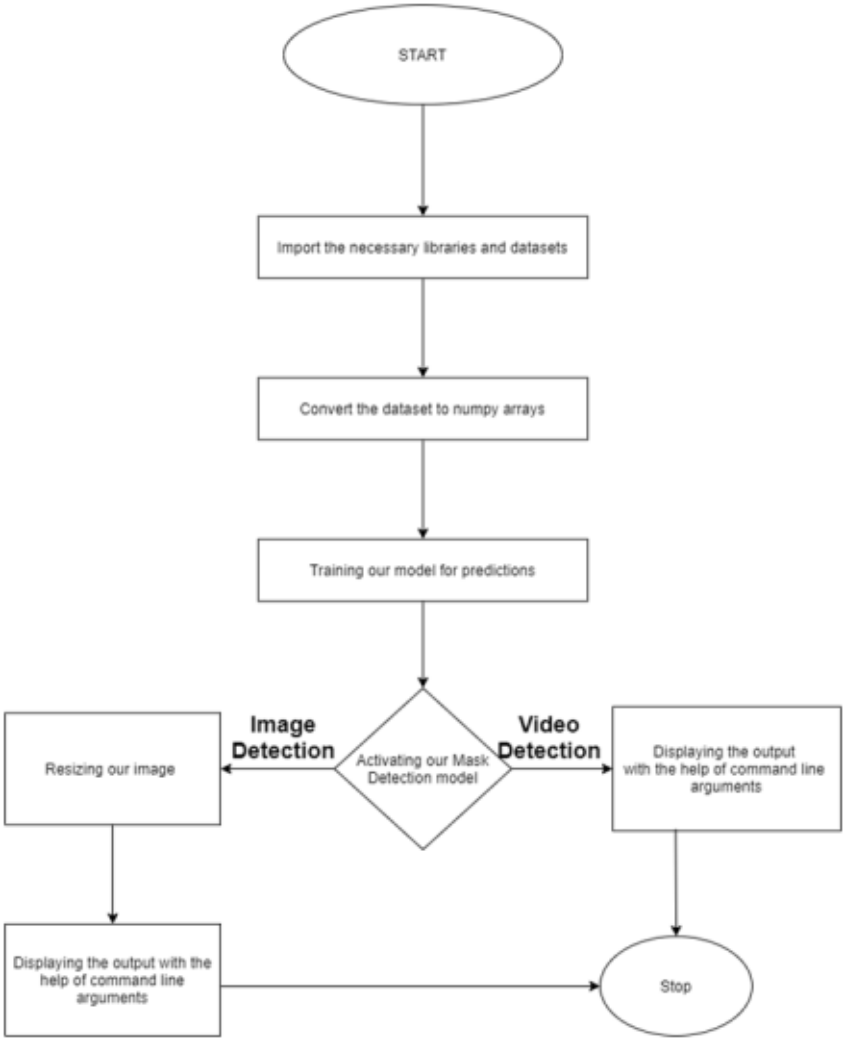

Figure 2: Flowchart for face-mask detection

The libraries that we have used in our project are

(I) OpenCV and OpenVino [29,30]

The Open-Vino toolkit is used to increase our accuracy of the model with the use of the Model Optimizer which is an inbuilt command line tool that carries out the static model analysis and optimizes deep learning models after which the training is done using Keras and Tensorflow frameworks. The model optimizer generates an Intermediate Representation (IR) output in the form of xml or bin files. We obtain the suitable xml file by using the model optimizer in Open-Vino to build our model and detect if a person is wearing mask or not along with the help of the Open - CV library which loads the image and then converts it to grayscale for using it as an input to our mask detection model and thus finally generating the output.

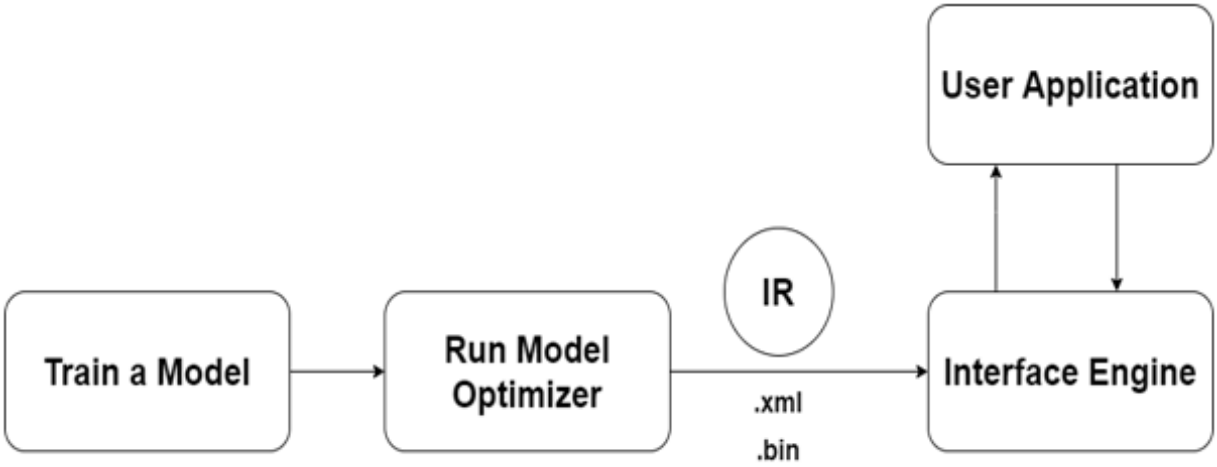

Figure 3: The Process of generating the xml file for mask detection

6. Result Analysis

The aforementioned result was mostly determined by video detections; however, in addition to video detections, our model is able to detect masks for sample photographs. The datasets are taken from Kaggle, and after that, they are split into two parts: with a mask and without a mask. These are the datasets that are utilised for the testing of our models.

6.1 The output of our model are as follows :-

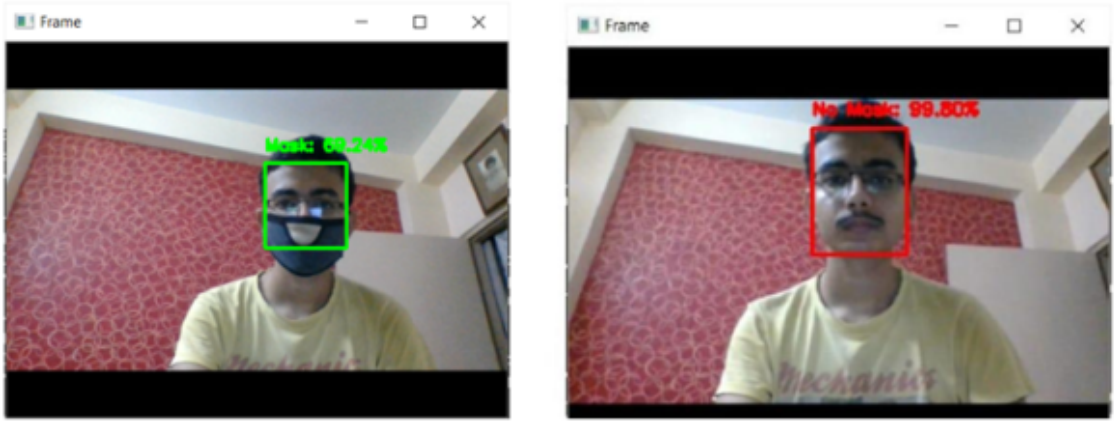

Figure 4 : Output showing presence and absence of mask as detected by our system

6.2 Sample image mask detection are shown as follows :-

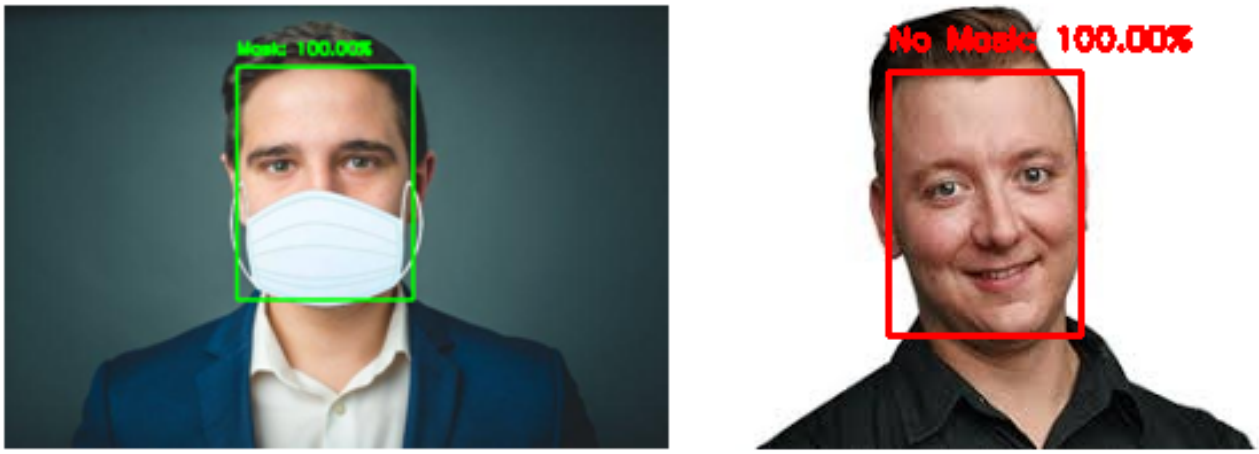

Figure 5 : Output showing presence and absence of mask as detected by our system for some sample photograph [24]

The accuracy of our model, as demonstrated above, is obtained by first comparing the data from the training set to the test values, and then expressing both our mistakes and our accuracy with the use of the matplotlib function in the Python programming language. In order to make our model more accurate, we have given it more data and given it an epoch value of 20. This will allow it to generate almost precise predictions and will ensure that suitable detections are made.

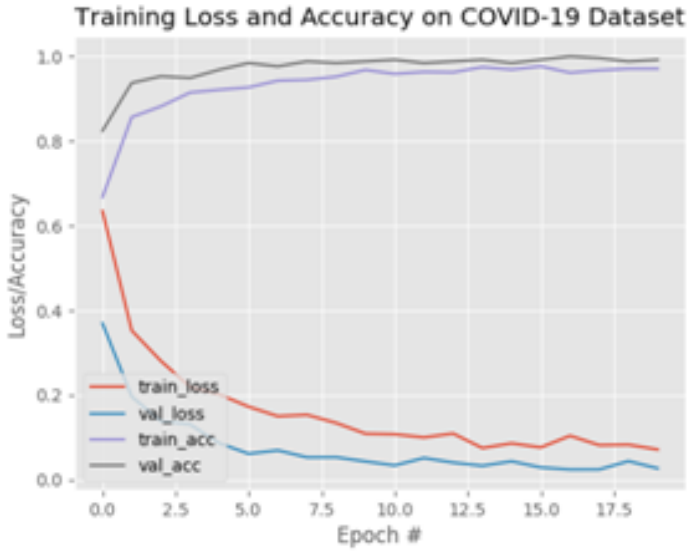

Figure 6 : The accuracy of the aforementioned model

The use of open vino toolkit provides us with an accuracy of 100 % in all cases for image testing.

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7. Conclusion

The project aimed in building a system that is capable of detecting face masks during this ongoing pandemic situation, this research was carried out with good accuracy. Since the libraries are open-source, this project can be implemented commercially in large scale. This project can also be improved by ensuring predictions can be made without resizing images and also implement it with other frameworks like pytorch instead of tensorflow-keras .

8. Future Prospects

Since the pandemic COVID-19 is spreading in an alarming rate, rapid developments are going on not only in virology, but also in various sectors of computer science like detection schemes using AI, prediction of count of affected people and many more. In this field as well we have developed a system that can detect mask on an individual. This research has a promising future and is of great significance. Any application based on android can be made that would detect presence or absence of mask which would send text message to the admin if any person violates or does not cover the face properly. We can also build up AI based system in shopping malls or educational institutes which will have an automated sliding door and the door will not open unless the person is wearing a mask.Apart , from mask detection this project can be modified to record attendance of students in educational institutions with face detections which will enable the teachers to do attendance calculation easily and also save the time taken to do roll call and maintain attendance separately in register books .

9. Acknowledgement

We would like to thank WHO for the all the guidelines, also we are thankful to INTEL for their open source user friendly platform OpenCV and also for provinding the Open-Vino toolkit to make our model predictions more accurate.

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