FACE MASK DETECTION TO ENSURE COVID-19 SAFETY BY USING OpenCV, TensorFlow and Keras

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APPROVAL

This Project titled "**Face Mask Detection to Ensure Covid-19 Safety by Using OpenCV, TensorFlow and Keras**", submitted by Md. Limon Hossain and Md. Mehedi Hasan to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on December 31, 2021.

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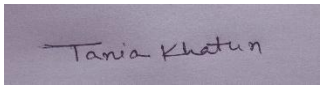

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We hereby declare that, this project has been done by us under the supervision of **Dr. Sheak Rashed Haider Noori, Associate Professor & Associate Head**, Department of CSE Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

We are living in a pandemic period. Covid-19 has changed our daily life in great manner. The economy of the world affected largely for the pandemic. We are under great health crisis. Thousands of people are being affected by this in daily basis. Droplets of an affected person can spread the virus among the people around him or her. Thus, an affected person is threat for others. As there are lots of people in public places, so the chances of transmission of the virus is very high in public places. From the world health organization we have known that Covid-19 can stay 14 days on a host without showing any symptoms. In this long time, the host may spread the virus among a community without his conscious. Again, another 48 hours is required to confirm if a suspect has covid-19 or not. But in this circumstances, 48 hours is also a long time. Many people can be affected in this time and then they will also spread the virus among millions. According to WHO, at this moment wearing a safe facemask is the best way that can stop the spreading of Covid-19. If people wear mask, their droplets will not spread in the air and people around him will be safe. We see various service providers refuse to give any services if a customer do not put mask in his face. So, detecting safe mask on person's face is become a highly appreciated work. In this project, we also going to do build a system that can perform this great task. Here we will use some basic deep learning and machine learning technique to perform the task. We will also need help of some library packages of python such as OpenCV, Keras and TensorFlow. Using all of this we hope to build a system that will detect if a person is putting facemask on his face or not correctly.

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CHAPTER 1

Introduction

1.1 Introduction

In the last two years Covid-19 [1] has spread all over the world. The crisis that has arrived by this pandemic has a large impact on us. It has changed our daily life. Now we sense our world differently than before. This deadly virus started spreading on December 2019 in Wuhan, China. We heard about it when 170 people was reported death in China. After that it was considered and announced as a global epidemic by World Health Organization (WHO). WHO named this virus as COVID-19. It is also called as corona virus. It is a saver acute respiratory of SARS-CoV-2 pattern virus. From the latest news till 19th November, 2021 by World Health Organization says that around 264 Million people in 200 countries around the world has affected by this virus and other 5.22 million people died by this. It has a high mortality rate than influenza. Influenza has a mortality rate of less than 1, on the other side Covid-19 has around 3.7 mortality rate. If a person affect by this had some symptoms. It spread one person to other if he get close to a affected person. But in the recent time, we see this virus can also be spread by a affected person who had no symptoms. In last two years it brought a great loss for the world and the humanity. It rises many social and environmental challenges. It broke the world's economy and public health faced a great threat. All the health organizations of the entire world recommends only one solution to be safe from this deadly virus that is, "wear face mask and maintain social distances". Social distance must be at least 2 Miters [2]. Only this can help to stop the spreading of the virus. So we see various public service providers refuse customer to give any services if the customer do not has facemask on their face and also who do not follow at least 3 foot social distances. Thus, at this moment it is great task to help the society by making a system with the help of computer vision [3] that can detect face mask and can monitor social distance.

1.2 Motivation

We see people are not maintaining Covid-19 rule. They don't wear facemask and keep social distancing. They go to shopping malls, bazars and everywhere that may throw us in great danger. This situation made us to do such kinds of projects.

1.3 Project

We have already know that, wearing facemask is considered as the best solution to stop the Covid-19 spreading. In this situation, we decided to work on this project that will be able to detect facemask on people's face in local places on real time. Our aim is to make a system that will have the ability to detect if a person is wearing a mask or not. In future we has a plan that we will integrate the system with surveillance cameras and automation door so that corona virus spreading can stop. We will do this with the help of computer vision and image processing.

1.4 Work Environment

To perform this task we need a dataset that has a large data of people faces with mask and without mask. As we want to detect facemask on real time we will use OpenCV to detect mask on real time or from live stream. Our project will be on Python. We will also take help from some python library like, OpenCV, Keras and TensorFlow. It is a Deep Learning and Convolutional Neural Network based project.

CHAPTER 2

Background

2.1 Literature Survey and related work

Mask detection architecture now has become a highly expected and also required architecture or model in this epidemic period. Various research had built various automated system lied with cameras in local places and areas that detects people are wearing facemask or not. Hybrid model also had been built using deep and classical machine learning. In various test Support Vector Machine (SVM) algorithm a dataset called Simulated Masked Face Dataset achieved 99.49% accuracy, 99.64% accuracy for Real-world Masked Face Dataset and 100% accuracy for Labeled Faces in the Wild Dataset.

98.70% accuracy achieved by another trained model where the data was differentiated with mask and without mask. Another facemask detector named RetinaFaceMask detector has a high efficiency rate [4]. This is a one-stage detector framework. It has a background attention module that is used to work on face mask detection and identification. It also has a feature called pyramid network that can combine high-level semantic data with various feature maps.

RetinaFaceMask has an impressive result on mask detection. It is considered as state of the art for its result. It has 1.5% to 2.3% high detection rate than average result. It's precision is 11% which is also higher about 5.9% than average result. It is an algorithm that eliminate the background attention module artifacts so that it can delete high union intersection projections and poor confidences.

An architecture has been built [5] that can find if one is taking or not taking mask in real life of streaming videos that are live. It works with person's front facing face photos with the help of SSD (full form: Single Shot Detector) that's the purpose is to serve object detection. Here the used concept is transfer learning of neural network. This algorithm is used to detect or finds if the facemask is on the face or not in live streamed videos and photos. According to report this model's accuracy, recall and precision are very good that is respectively 100%, 99% and 99%. So this is considered a very good model.

A model [6] is designed to detect face mask in motion has been developed. This approach used some basic library packages of machine learning. The library are Scikit-learn,

OpenCV, Tensorflow and Keras. This model obtains around 95.76% accuracy for a dataset and 94.59% accuracy for another dataset.

An architecture [7] that can detect if the person is wearing mask in local area. This process was made by re-arranging a pre-trained standard model. It is a deep learning model named InceptionV3. A dataset named SMFD is often used by the developer to train the model. In this process the public facemask is put on and after that it is trained. For better training and testing this process is followed.

A technique called image augmentation help to upgrade training rate and testing rate of various system and model for the usability of data that are restricted. This upgrade system obtained around 100% accuracy during testing and acquired 99.9% precision during training.

A computer vision based real time approach is very much efficient. It can detect if anyone is wearing facemask and is violating social distancing in local places. An advanced deep learning algorithm is used to do that task. A geometric approaches is used to create this model. It is a robust model and it can detect, track and validation very well.

A credit card size computer called Rasberry-pi4 which was implanted with cameras in various public places. A robust architecture was also lied with this small computer. OpenCV, a framework in neural network is used here. MobileNetV2 is a feature of OpenCV that is used in streaming video for face detection. These are used to obtained accuracy recognition and resource limitation in the field of facemask detection which can be lied with cctv cameras is local places to make people wear facemask.

There are a lot of hybrid and other architecture that are built for detecting face mask with the help of deep learning and classical machine learning. Among them there is a system with having two components. One components is for extracting features with the help of Resnet50. The other one is for the classification of facemask with the help of Support Vector Machine. An algorithm and a decision tree is dedicated for the system. Three different dataset is used in the system. The datasets are Labelled Faces in the Wild (LFW), Real World Masked Face Dataset (RMFD) and Simulated Masked Face Dataset (SMFD). After the experiment in Support Vector Machine algorithm, these three dataset obtained 99.49% accuracy for SMFD, 99.64% accuracy for RMFD and 100% accuracy for LFW.

Another approaches that find facemask in the roadside and public places by CCTV cameras and if a person violate the covid-19 rule, the system will notify the responsible authorities. This system is built with the help of Convolutional Neural Network (CNN). CNN is used for extracting features from the images. This system showed the accuracy around 97.87%. Radu tudor and Nicolae done a different work [8]. Their proposed model can detect if there is facemask or not on a speech. They done this by data augmentation model. They used ResNet neural organizations which has different depths.

There is a similar model [9] like this where researchers used GAN-based network. They done it by two discriminator. They used the CelebA dataset. At first they remove the mask and then rebuild it.

2.2 Research Summary

After reading all the research paper and project report we find mask detection becoming popular day by day. There are already many approaches developed by many researchers that can detect mask. It is very similar to face detection. These reports and papers helped us a lot to fulfill our job. We knew many algorithm related with our task.

CHAPTER 3

Library Packages and Requirements

3.1 TensorFlow

TensorFlow is a python algorithm that used for performing ML (machine learning) and AI (artificial intelligence). It is an open-source and totally free software library. It was built and optimized for the task of Machine Learning implementation. It has a wide range of applications in CSE and software engineering. Various tasks like voice recognition, geographic information extraction, sentiment analysis, text summarization, information retrieval, computer vision, flaw detection and computational drug discovery can perform by this [10]. It work in the backend in convolutional neural network and reshape image in image processing.

3.2 Keras

In simple word, Keras is an API. this API has designed for humans and this is not compatible for machines. It is also an open source software library. It works with TensorFlow library and provides a python interface for AI and neural networks. It also gives an interface for TensorFlow. It works as model and layer [11] based structure. It is supported by multiple backends such as Microsoft Cognitive Toolkit, PlaidML, Theano, TensorFlow etc.

3.3 OpenCV

OpenCV is a python Library. It is open-source and made by Intel packages. It's main application area is in machine learning sector. It is optimized to perform various tasks such as differentiate, detect and recognize human faces, detect and recognize objects. It also can detect movements in real life streaming and recordings, it can trace and follow eye movement and gesture. It also can track camera actions like search images from a database and perceive landscape [12]. In this project we will use openCV to perform such tasks and it will help us to resize and color conversion of our dataset. It uses open source Apache 2 license.

3.4 MobileNetV2

MobileNetV2 [13] is a model of OpenCV. It is the technology of mobile visual detection and recognition. It is used in classification of data, detecting object from video and segment semanticaly [14]. The model is developed using an intelligent separable convolution network. It is very light weight model which reduce the complexity cost and size of the network significantly. Thus it is mostly acceptable for small devices that has a small computing power. MobileNetV2 has a module introduced called reverse residual structure. It remove the nonlinearity from the narrow layer. This model can extract feature and used in semantic segmentation and object recognition or detection.

3.5 NumPy

In Python programming language, NumPy [15] is a library used for various mathematical functions. It gives support in large and multi-dimensional matrixes and arrays. It allows high level functions that can operate those arrays. It also support in linear algebra routines, random number generators, Fourier transforms etc.

3.6 imutils

imutils [16] is a A series of OpenCV convenience function that can perform the basics rotation, transformation, resizing, skeletonization etc. We will use this series for basics image processing.

3.7 SciPy

SciPy [17] is open-source library that offers algorithm for python. It is used for technical and scientific computing. It contains modules for optimization, interpolation, linear algebra, special functions, integration, FFT, ODE solvers, signal and image processing and other tasks.

3.8 Matplotlib

Matplotlib [18] is also an open source library for Python programming language. This library packages is used for plotting. It mainly provides an plot API for applications. It needs a GUI toolkit. There are many such toolkits like Tkinter, Qt, wxPython or GTK. Matplotlib uses for interactive visualization. It gives a static and animated look for the data.

CHAPTER 4

Requirements and Dependencies

4.1 Requirements

- programming Languages: Python
- IDE: PyCharm
- Library Packages: OpenCV
  TensorFlow
  Keras
- A custom Dataset

4.2 Dataset

In this project we used a dataset [19] that is consist of 3833 images in which 1915 images are with facemask and other 1918 images are without facemask. Fig.4.2.1 contains some of front facing picture where people are wearing facemask. Face masks are different in color and shape.

Figure 4.2.1: With facemask dataset

Fig. 4.2.2 contains another 1918 front facing images which are without face mask. There are random people around the world. Some are black, some are white and some other are brown. We take all types of people's photo.

Figure 4.2.2: Without facemask dataset

CHAPTER 5

Methodology

We will follow the methodology given below, where there is only four simple steps.

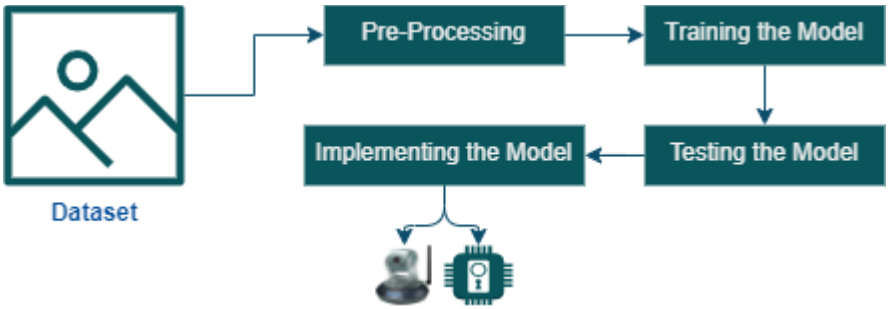

Figure 5.1: Methodology

5.1 Data Collection and Pre-processing

This project uses a custom dataset that is collected from a public domain. The dataset consist of a large collection of images where there is image of people wearing mask and not wearing mask. We have to per-process this images to train the mask detection model. We have divided the dataset into two part for training and for testing. The training part consist of 80% of all images to perform a better accuracy. Other 20% images is used for testing the prediction accuracy of the algorithm. The training dataset are divided of classified into two categories that's are with mask and without mask.

Mainly data pre-processing is needed for making the dataset more user friendly. In this part we will visualize the transforming abstract data in many meaningful way. Images reshaping is also done in this section. Now the dataset is ready for training.

5.2 Building and Training the Model

Our proposed system has trained with the help of convolutional neural network. It also used MobileNetV2 model of TensorFlow which is an efficient architecture. This architecture can be used where there is a limited computing power. It can detect people and face in real time. In the training section we loaded our custom dataset into the project directory. We labeled the dataset's images and then applied the training algorithm. Previously, we resized the images into 224*224 pixels. We converted the images into numpy array format and added label on it. With the help of TensorFlow

we augmented the data. We initialized INIT_LR (initial learning rate) for the model as 1e-4. Here number of epoch (EPOCHS) and batch size (BS) is set as 20 and 32 respectably.

We used “relu” to make linear data to non-linear and set the pool size 7*7. Here the dense layer (the final layer) has 100 neurons and it is added with ReLu activation. To optimize the dataset we used “adam” optimizer.

5.3 Model Testing

When the model is trained properly, it is ready for testing. In this section we test the model by confidence score. At the early stage we separated 20% of the dataset for testing. Our project uses the computer’s webcam to capture images. This project detect face at first and then it shows a square bounding box around the face. If the person is wearing mask the square is green and if not the bounding box (Fig. 2) is red.

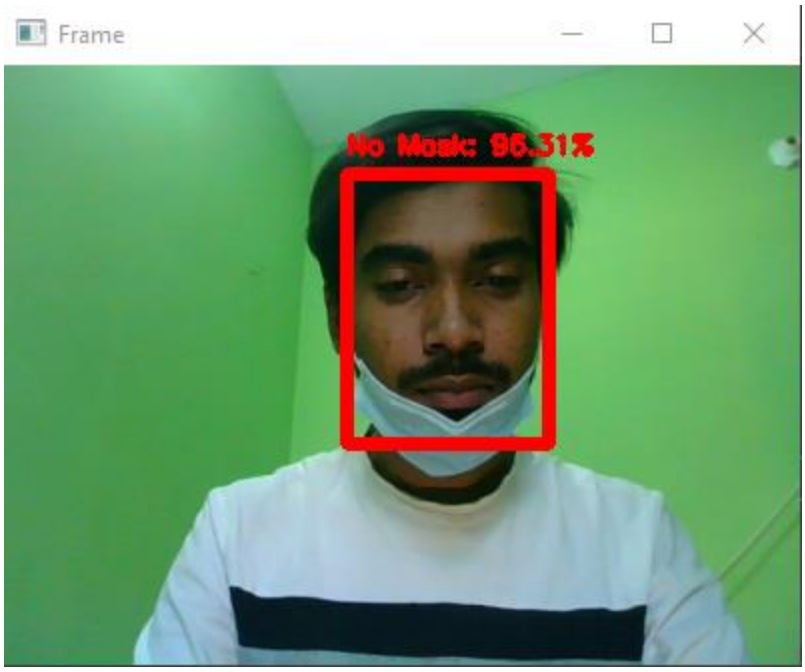

Figure. 5.3.1: Bounding box

5.4 Implementing the Model (proposed)

The system will be connected with a local authority server. If a person do not wear a mask, the system will send an alert to the authority. Then the authority can take action against the person.

CHAPTER 6

RESULT AND ANALYSIS

6.1 Result

The system is working properly. It can detect weather a person is wearing a mask and not. In the fig. 6.1.1 I'm not wearing facemask. The project shows a red bounding box

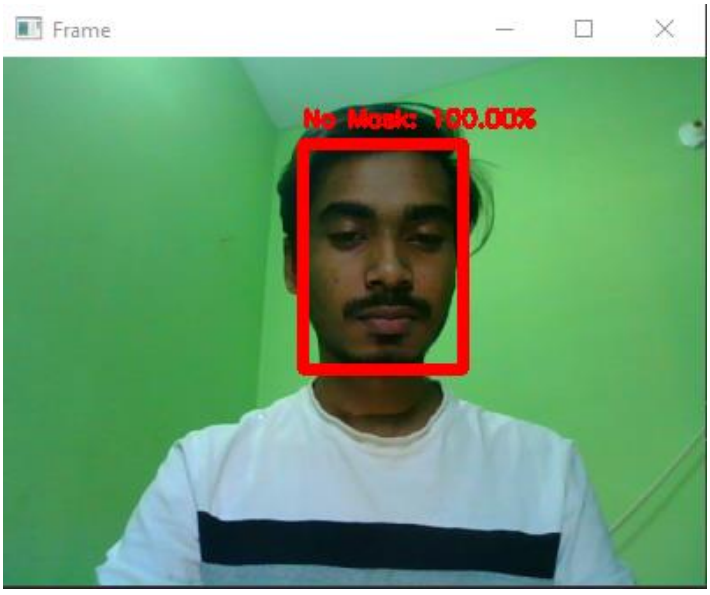

Figure. 6.1.1: Detecting no mask

and I covered my face with my hands and pretend that I wore a facemask but the system can also detect that (fig 6.1.2).

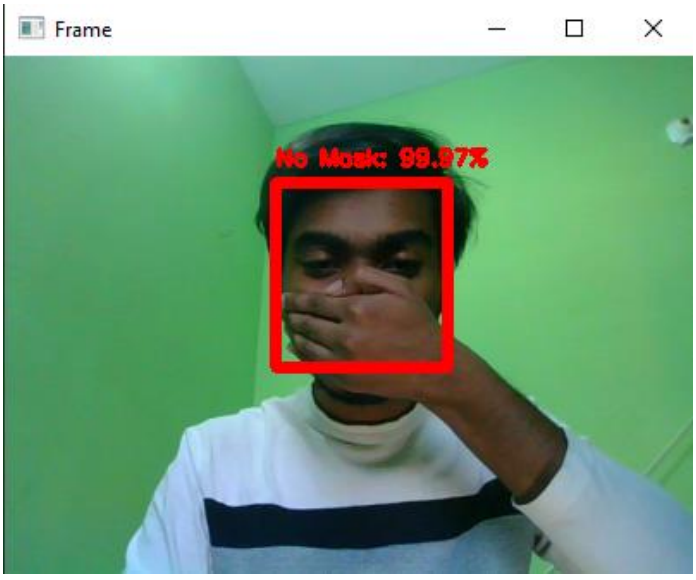

Figure. 6.1.2: Detecting no mask

I also put my face mask on my my chin area to cheque if it can detect of not. But the system also can detect that (fig. 6.1.3).

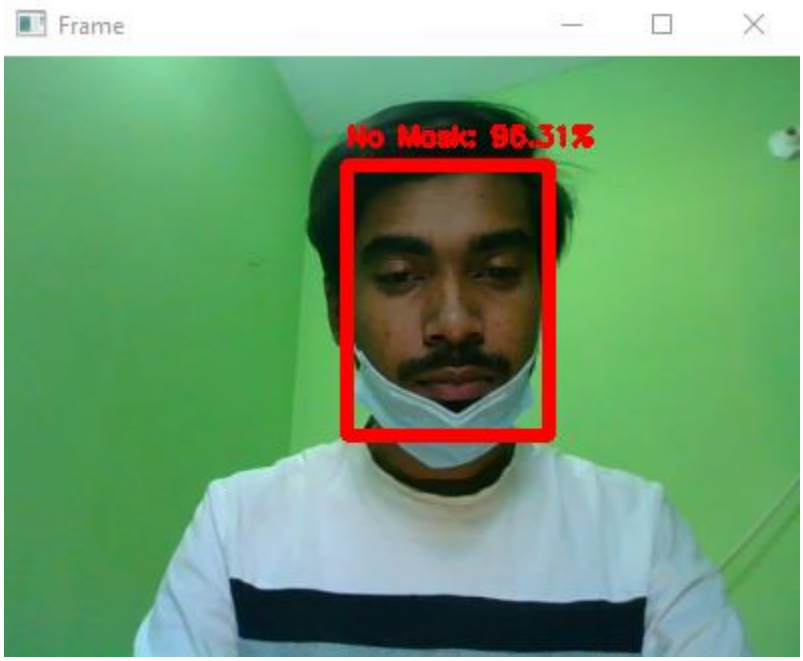

Figure. 6.1.3: Detecting no mask

And finally I wear a face mask and it can detect that as expected (fig. 6.1.4)

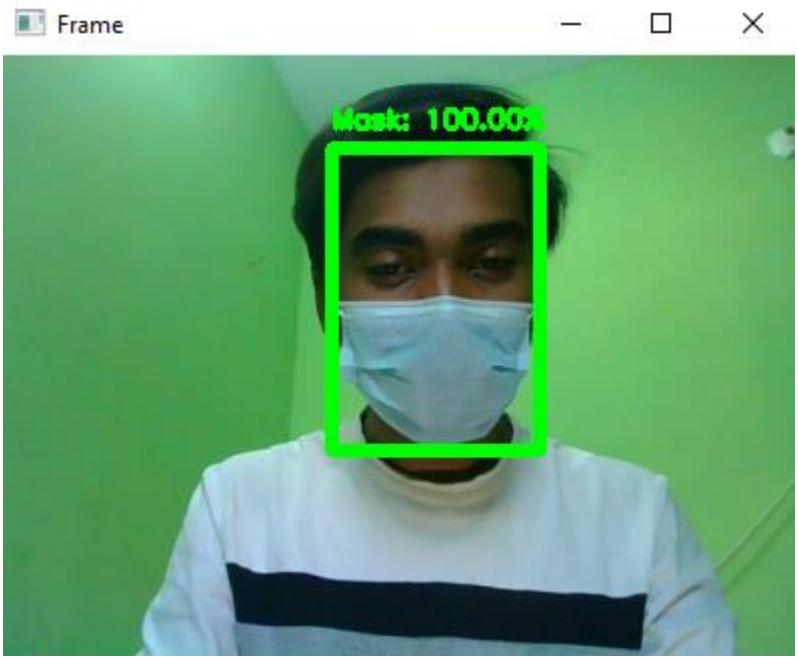

Figure. 6.1.4: Detecting mask

6.2 Analysis

The system is working properly and gave a decent accuracy. from the fig. 4.1 we can see it has around 96.11% accuracy. It also has lower training and validation loss(fig. 6.2.1). It also can differentiate between nose, chin, eye, mouth area and fake mask.

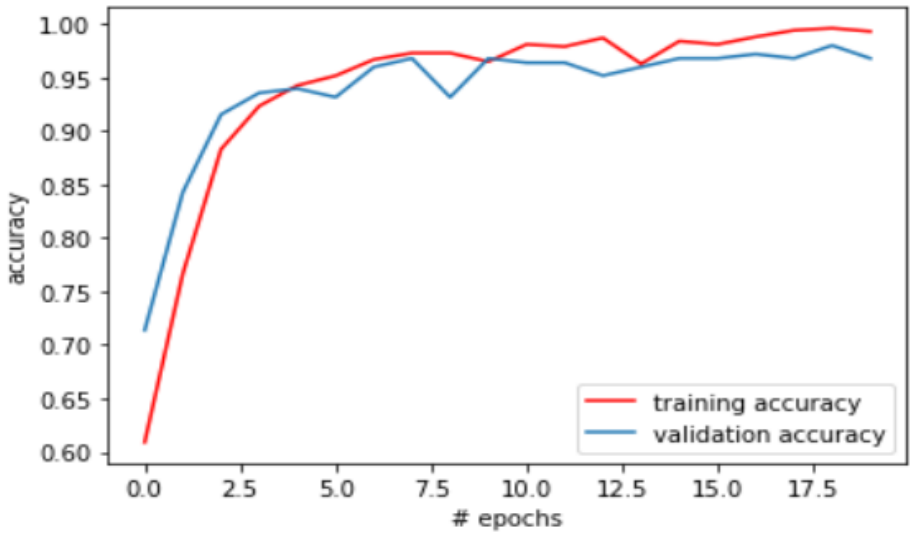

Figure. 6.2.1: Epochs vs accuracy

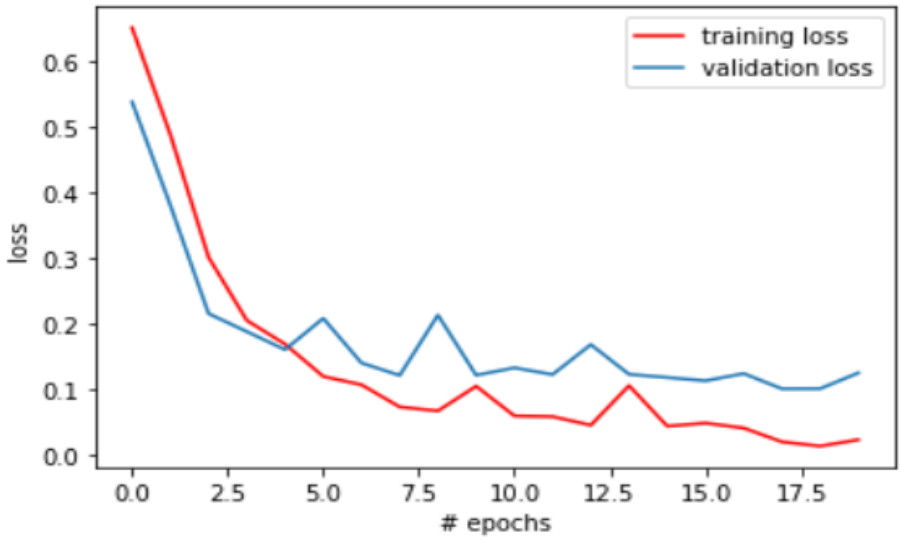

Figure. 6.2.2: Epochs vs loss

CHAPTER 7

FUTURE WORK

7.1 Future Work

We want to make this project bigger. we have a plan to,

- attach this project with a authority server so that government can control the people and make them wear mask.
- Implemente this with automation door of a public service center or shoping mall. So that if anyone do not wear mask then the door will not open.
- Identifie what type of mask a person is wearing.
- Identifie a person is doing a crime or not by wearing a facemask.

CHAPTER 8

CONCLUSION

8.1 Conclusion

We all know that Covid-19 affected person is increasing day by day. Besides many new varient of Covid-19 are spreading. So, checking a person is wearing a face mask or not is mandatory. In this circumstances, our project can replace human from this job and it also can save human time and energy. It can be used in public service and help to decreas it's spreading. This system can implemented in airport, hospital, shoping mall, various transport station and tackle the situation effectively.

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