Indian Institute of Information Technology Allahabad

Department of Information Technology

Image and Video Processing Course 2021

Progress Report on

Real Time Face Mask Detection Model

as part of C1 assessment

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Contents

1 Introduction

1.1 Abstract

The rapid outbreak of COVID-19 has caused serious harm and infected tens of millions of people worldwide. Since there is no specific treatment, wearing masks has become an effective method to prevent the transmission of COVID-19 and is required in most public areas, which has also led to a growing demand for automatic real-time mask detection services to replace manual reminding

To contribute towards communal health, this paper aims to devise a highly accurate and real-time technique that can efficiently detect non-mask faces in public and thus, enforce the wearing of masks. We have used deep learning and open CV to develop our face detector model.

The trend of wearing face masks in public is rising due to the COVID- 19 coronavirus epidemic all over the world. Before Covid-19, People used to wear masks to protect their health from air pollution. While other people are self-conscious about their looks, they hide their emotions from the public by hiding their faces. Scientists proved that wearing face masks works on impeding COVID-19 transmission. COVID19 (known as coronavirus) is the latest epidemic virus that has hit human health in the last century. In 2020, the rapid spreading of COVID-19 has forced the World Health Organization to declare COVID- 19 as a global pandemic.

Here we introduce a mask face detection model that is based on computer vision and deep learning. The proposed model can be integrated with surveillance cameras to impede the COVID-19 transmission by allowing the detection of people who are wearing masks not wearing face masks. The model is integration between deep learning and classical machine learning techniques with open cv, tensor flow and as. We have used deep transfer leering for feature extractions and combined it with three classical machine learning algorithms. We introduced a comparison between them to find the most suitable algorithm that achieved the highest accuracy and consumed the least time in the process of training and detection.

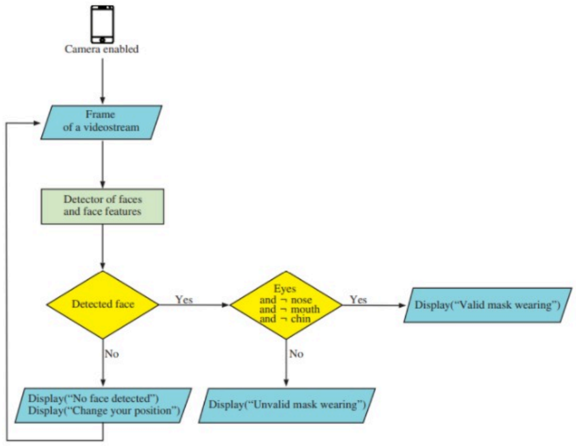
Figure 1: Various configurations related to the mask wearing.

1.2 Machine Learning

Machine learning (ML)is the study of computer algorithms that improve automatically through experience. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as ”training data”, in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop conventional algorithms to perform the needed tasks. Machine learning is closely related to computational statistics, which focuses on making predictions using computers. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a related field of study, focusing on exploratory data analysis through unsupervised learning.

1.3 Computer Vision

Computer vision is an interdisciplinary scientific field that deals with how computers can gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to understand and automate tasks that the human visual system can do, Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high dimensional data from the real world in order to produce numerical or symbolic information, e.g. in the forms of decisions, Understanding in this context means the transformation of visual images (the input of the retina)into descriptions of the world that make sense to thought processes and can elicit appropriate action. This image understanding can be seen as the disentangling of symbolic information from image data using models constructed with the aid of geometry, physics, statistics, and learning theory.



1.4 Dataset

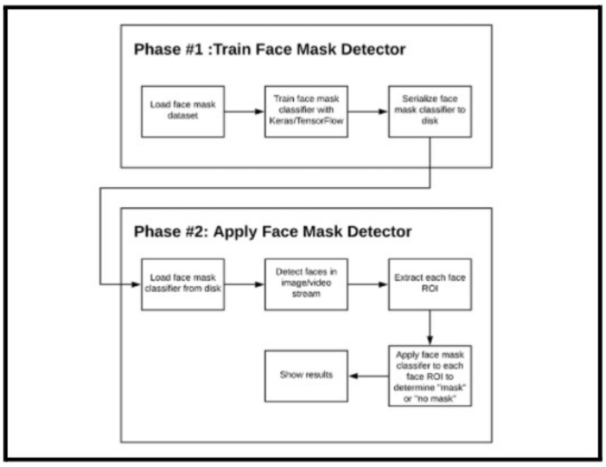
A dataset (or data set) is a collection of data, usually presented in tabular form. Each column represents a particular variable. Each row corresponds to a given member of the dataset in question. It lists values for each of the variables, such as height and weight of an object. Each value is known as a datum.

2 Methodology

The proposed system focuses on how to identify the person on image/video stream wearing a face mask with the help of computer vision and deep learning algorithm by using the OpenCV, Tensor flow, python google colab dataset. We have used the following steps for our project:

1. The main task of our project is to recognize faces correctly and to do that we need to build a dataset of faces wearing face masks.
2. In the dataset, we apply face detection to compute the bounding box location of the face in the image.
3. Once we know where in the image the face is, we can extract the face Region of Interest (ROI):
4. And from there, we apply facial landmarks, allowing us to localize the eyes, nose, mouth, etc.
5. Then we will again use facial landmarks to find if the person is wearing a mask or not.

Language Used: Python
Libraries Used: Tensorflow, Keras, Imutils, Numpy, OpenCV, Matplotlib, Scipy



2.1 Data Source

The majority of the images were augmented by OpenCV. The set of images were already labeled “mask” and “no mask”. The images that were present were of different sizes and resolutions, probably extracted from different sources or from machines (cameras) of different resolutions.

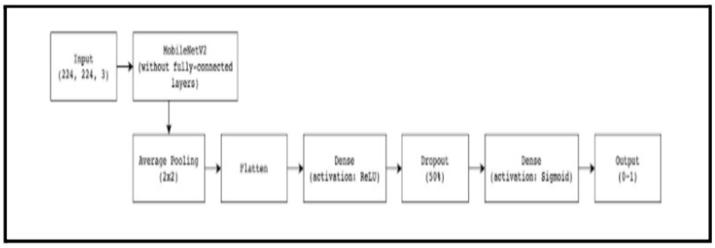
2.2 Purpose of the model

Considering the covid-19 outbreak, we think this is the best project that we can work on as a python developer. Today everyone is aware of taking precaution and safety measures regarding covid-19, so face mask detection will play a huge role to avoid coronavirus. This project helps us to spread awareness among people using face masks properly. It detects the face mask on your face whether the person is hiding his/her face by mask or not. It also checks if the face mask properly covers both your face, nose and mouth.

2.3 Architecture of the Model

In this project, we’ll discuss our two-phase COVID-19 face mask detector, detailing how our computer vision/deep learning pipeline will be implemented. From there, we’ll review the dataset we’ll be using to train our custom face mask detector. We’ll then show you how to implement a Python script to train a face mask detector on our dataset using Ker as and TensorFlow. We’ll use this Python script to train a face mask detector and review the results. Given the trained COVID-19 face mask detector, we’ll proceed to implement two more additional Python scripts used to Detect face masks in real-time video streams.

2.4 Dataflow Process



3 Software and Hardware Requirements

3.1 Software Requirements

1. Operating System - Linux, Windows7,8.1,10
2. Programming Language - Python.
3. Libraries used - Tensorflow, Keras,Imutils,Numpy,OpenCV,Matplotlib,Scipy
4. Database - Google DATASET
5. Other Technologies used - MobileNetV2, Caffe-based Face Detection, Scikit.

3.2 Hardware Requirements

1. Processor - Dual Core i3
2. Display
3. Hard Disk - 80 GB
4. Ram - 2 GB
5. Key-Board
6. Mouse

4 System Analysis

4.1 Experimental Study

Experiments have been conducted by exploiting resources in design engineering and in image analysis accessible in Android and OpenCV environments. We observe that the use of Haar-like feature descriptors for detecting face and face features is sensitive. Indeed, various false detections can occur according to the condition of illumination during the acquisition, and to objects or textures that are visible out of the face.

```
.
├── dataset
│   ├── with_mask [690 entries]
│   └── without_mask [686 entries]
├── examples
│   ├── example_01.png
│   ├── example_02.png
│   └── example_03.png
├── face_detector
│   ├── deploy.prototxt
│   └── res10_300x300_ssd_iter_140000.caffemodel
├── detect_mask_image.py
├── detect_mask_video.py
├── mask_detector.model
├── plot.png
└── train_mask_detector.py
```

4.2 Face-Mask Detection Dataset

The dataset consists of 2000 images belonging to two different classes:

1. with-mask : 1000 images.
2. without-mask : 1000 images.

Our Goal is to train a custom deep learning model to detect whether a person is or not wearing a mask. For this project, we use the dataset, which consists of 1000 masked faces and 1000 normal pr without-mask with a minimum size of 32×32. The faces in this dataset have different orientation and occlusion degrees. The dataset is divided into 3 parts for training and validation and a test set with 700, 100 and 200 images, respectively. The dataset has been attached in the Project Zip File.

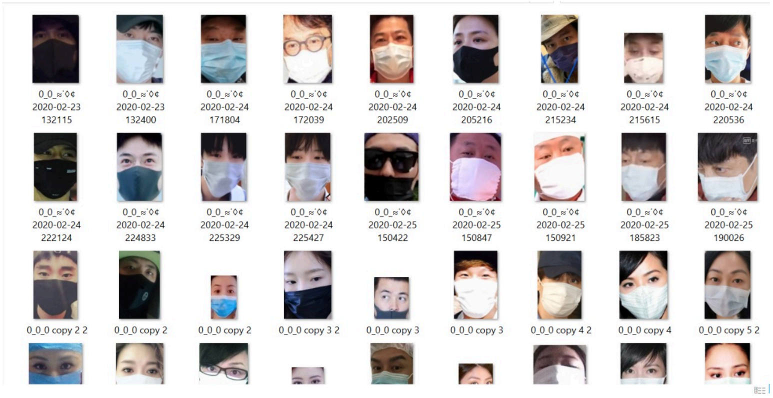


Figure 1: Sample images of With-Mask people(From the dataset)

Figure 2: Sample Images of With-Mask and Without-Mask People(Not from the dataset)

4.3 Process the data

```
#After execution of this cell all the necessary modules will be impported and the version
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.applications import MobileNetV2
from tensorflow.keras.layers import AveragePooling2D
from tensorflow.keras.layers import Dropout
from tensorflow.keras.layers import Flatten
from tensorflow.keras.layers import Dense
from tensorflow.keras.layers import Input
from tensorflow.keras.models import Model
from tensorflow.keras.models import load_model
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.applications.mobilenet_v2 import preprocess_input
from tensorflow.keras.preprocessing.image import img_to_array
from tensorflow.keras.preprocessing.image import load_img
from tensorflow.keras.utils import to_categorical
from sklearn.preprocessing import LabelBinarizer
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report
import imutils
from imutils import paths
import matplotlib.pyplot as plt
import numpy as np
import argparse
import os
import cv2
from google.colab.patches import cv2_imshow
from imutils.video import VideoStream
import time
import sys
import tensorflow as tf
```

5 Testing Suggestions for Improvement

5.1 Prediction on Testing

We tried using three different base models for detecting ‘mask’ or ‘no mask’. The exercise was done to find the best fit model in our scenario. The evaluation process consists of first looking at the classification report which gives us insight towards precision, recall and F1 score. We implemented our model on images containing one and more faces. We also implemented it on videos and live video streams by removing and wearing masks one by one.

$$Precision = \frac{True\ Positives}{Positives + False\ Positives}$$

$$Recall = \frac{True\ Positives}{Positives + False\ Negatives}$$

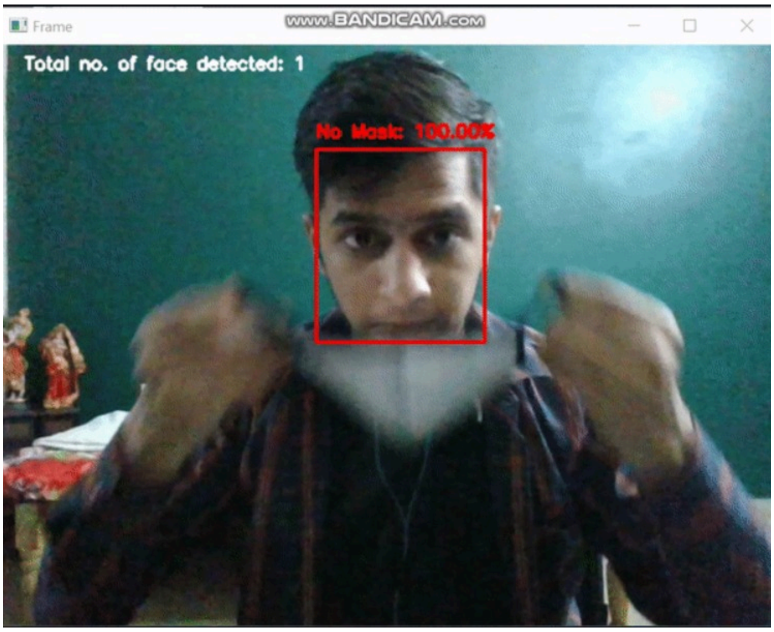
$$Accuracy = \frac{True\ Positives + True\ Negatives}{Positives + Negatives}$$

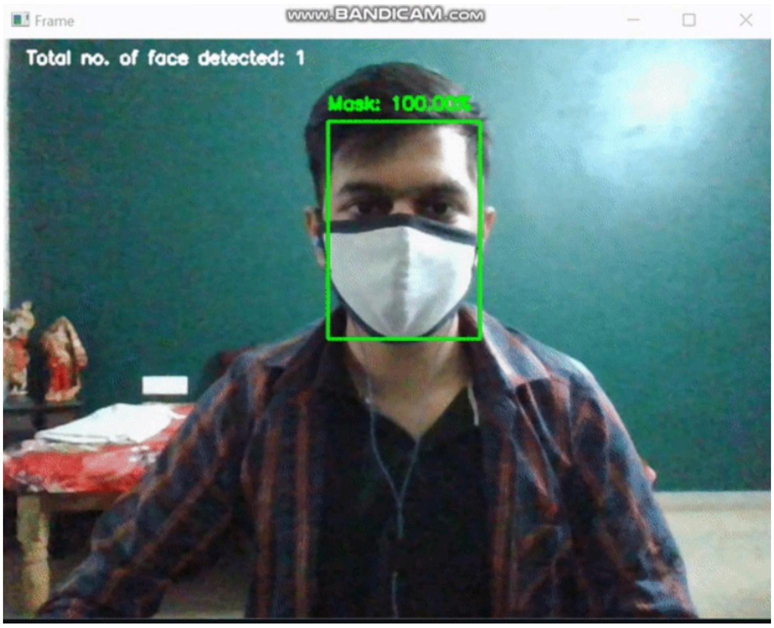
5.2 Suggestions for Improvement

To improve our face mask model detection model further,we should gather -

1. Actual Images(rather than artificially generated images) of people wearing masks.
2. Secondly,we should also gather images of faces that may ”confuse” our classifier into thinking that the person is wearing a mask when in fact they are not - some potential examples include shirts wrapped around faces,bandana over the mouth and so on.
3. Finally we can also consider training a dedicated two-class object detector rather than a simple image classifier.

5.3 Demo





6 Conclusions

We have applied the concepts we learnt in Machine learning with Python and Google dataset which was complemented with the knowledge gained through Image Video Processing course where we brought in consideration the features of face detection and tracking to our Project. In this project, we have developed a deep learning model for face mask detection using Python, Keras, and OpenCV. We developed the face mask detector model for detecting whether a person is wearing a mask or not. We have trained the model using Keras with network architecture. Training the model is the first part of this project and testing using a webcam using OpenCV is the second part. This project can be integrated with embedded systems for application in densely populated areas, residential districts, large-scale manufacturers and other enterprises to ensure safety. The sole purpose of this application is to ease this process and make a fully automatic face-mask detection application.A method is designed for checking the correct wearing of face protection mask from a video selfie. Different analysis scenarios have been experimented using diverse types of conventional masks and varied acquisition conditions. The performance of the designed method relies on the efficiency of the exploited face and face-feature detectors. In the present study, wearing glasses had no negative effect. The use of rigid masks seems preferable because they reduce possibilities of wrong positioning on the face. For this latter, the designed prototype can particularly be efficient.

7 References

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