A FACEMASK DETECTOR USING MACHINE LEARNING AND IMAGE PROCESSING TECHNIQUES

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ABSTRACT

Changes in the lifestyle of everyone around the world. In those changes wearing a mask has been very vital to every individual. Detection of people who are not wearing masks is a challenge due to Outbreak of the Coronavirus pandemic has created various the large number of populations. This project can be used in schools, hospitals, banks, airports, and etc. as a digitalized scanning tool. The technique of detecting people's faces and segregating them into two classes namely the people with masks and people without masks is done with the help of image processing and deep learning. With the help of this project, a person who is intended to monitor the people can be seated in a remote area and still can monitor efficiently and give instructions accordingly. Various libraries of python such as OpenCV, Tensorflow and Keras. In Deep Learning Convolution Neural Networks is a class Deep Neural Networks which is used to train the models used for this project.

Keywords: Convolutional Neural Networks, Deep learning, Image Processing, OpenCV, Tensor flow.

INTRODUCTION

The trend of porting face mask publically is rising because of the Covid-19 epidemic everywhere in the world. Because Covid-19 people wont to wear mask to shield their health from air pollution. Whereas other are self-conscious concerning their looks, they hide their emotions from the general public by activity their faces. Somebody treated the wearing face masks works on hindering Covid-19 transmission. Covid-19 is that the last epidemic virus

that hit the human health within the last century. In 2020, the fast spreading of Covid-19 has forced the who to declare Covid-19 as international pandemic. Quite 5 million cases were infected by Covid-19 in not up to half dozen month across 188 countries. The virus spreads through shut contact and in packed and overcrowded areas. The corona virus epidemic has given rise to a unprecedented degree of worldwide scientific cooperation. Computer science supported machine learning and deep learning will facilitate to fight Covid-19 in several ways. Machine learning a valuate huge quantities of knowledge to forecast the distribution of Covid-19, to function early warning mechanism for potential pandemics, and classify vulnerable population. Folks are forced by laws to wear face masks publically many countries. These rules and law we have a tendency yore developed as associate degree action to the exponential growth in cases an deaths in several areas.

However, the method observation massive teams of individuals is changing into a lot of difficult. The monitoring process involves the finding of anyone who isn't sporting a face mask. Here we introduce a mask face detection model that's supported machine learning and image process techniques. The planned model may be detect the mask with image and real time detection people wearing mask or not wearing a mask. The model is integration between deep learning and classical machine learning techniques with OvenCV, Tensor Flow and Keras. We have a tendency to introduced a comparison between them to seek out the foremost appropriate algorithm program that achieved the very best accuracy and consumed the smallest amount time within the method of coaching and detection.

LITERATURE SURVEY

Generally, most of the projects specialize in face construction identity recognition when wearing mask. During this projects, the focus is on recognizing the people that wearing mask, or not help in decreasing the transmission and spreading of covid-19. The scientist has proven that wearing a mask help in minimizing the spreading rate of Covid-19.

In [1], the authors developed a face mask wearing condition identification method. They were ready to classify three categories of face mask-wearing. The categories are face mask-wearing, incorrect face mask-wearing and no face mask-wearing. Saber et al [2], have applied the principal component analysis on masked and unmasked face recognition to acknowledge the person. Also, PCA was utilized in[3]. The author proposed a way that's used for removing glasses from human frontal faces. In[4], the authors used the YOLOv3 algorithm for face detection. YOLOv3 uses Darknet-53 because the backbone. Nizam et al [5] proposed a completely unique GAN-based *network, which* will automatically remove mask covering the face area and regenerate the image by building the missing hole. In [6], the authors presented a system for detecting the presence or absence of a compulsory medical mask within the OR. *The* general is to attenuate the false positive face detection as possible without missing mask detection so as to trigger alarms just for medical staff who don't wear a surgical mask.Shaik et al [7] used deep learning real-time face emotion classification and recognition. They used VGG-16 to classify seven countenance.

Under the present Covid-19 lock-in time, this technique is effective in preventing spread in may use cases. Here are some use cases which will benefit form system.

Airports: the proposed system could also be vital find travelers at airports. there's no mask. The traveler's data are often captured as a video within the system at the doorway . Any

passenger who finds no mask will alert the airport authorities send in order that they can act quickly. [13]

Hospital: the proposed system are often integrated with CCTV cameras, and therefore the data are often manage to ascertain if its employees are wearing masks. If you discover some doctors . If the aren't wearing a mask, they're going to receive a reminder to wear a mask. [22]

Office: The proposed system can help to take care of safety standards to stop . The spread of covid-19 or any such airborne disease. If some employees aren't wearing masks, they're going to receive reminders to wear mask. [22]

The choice of the system must be supported the simplest performance. So, I'm using the simplest system performance indicators in order that you'll large –scale implementation.

The system has been used with the MobileNetV2 classifier:

MobileNetV2[12]: MobileNetV2 is that the latest technology of mobile visual recognition, including classification, object detection and semantic segmentation [24]. The classifier uses deep intelligent separable convolution, its purpose is to significantly reduce the complexity cost and model size of the network, so it's suitable for mobile devices, or devices with low computing power. In MobileNetV2, another best module introduced is that the reverse residual structure. The nonlinearity within the narrow layer is removed. Maintain because the backbone of feature extraction, MobileNetV2 achieves the simplest performance in object detection and semantic segmentation.

For MobileNetV2 classifier, ADAM optimizer has been applied to see performance:

ADAM[13]: Adam, a stochastic optimization algorithm supported step the target function is predicated on an adaptive estimation of low-order moments. this manner it's computationally

efficient and may be executed almost without memory. It's the diagonal of the gradient is rescaled unchanged, which is extremely suitable for the subsequent problems large in terms of knowledge and/or parameters. Hyper parameters are intuitive explain that they typically don't require much adjustment. The empirical results show that Adam it works well in practice and may be compared with other stochastic optimization method.

RELATED WORK

Machine Learning

Machine learning is a method of teaching prediction based on some data. it is a branch of artificial intelligence, Which numerically improves on data. over as more data as add in algorithm the performance of the system is improved.

These are the three types of machine learning:

Supervised learning its supervised learning we have several data points or samples described using predictive variables or features and the target variable our data represented in table structure. Game supervised learning is build a model its able to predict the target variable.

Unsupervised learning is a machine learning task the uncovering hidden patterns from unlabeled data.

Reinforcement learning (RL) in which machine or software agents interact with an environment reinforcement learning agents are able to automatically figure out how to optimize their behavior given a system of reward and punishments reinforcement learning draws inspiration from behavioral psychology..

Computer Vision

It is a field that include processing analyzing and understanding image in general high dimensional data from the real world in order to produce numerical and symbolic information or it is a technology of science and machine that see it obtain information from images.

Deep Learning

Deep learning is a powerful set of techniques for learning using neural network. Neural network are beautiful biologically inspired programing paradigm which enables a computer to learn from data. These are learning algorithms.

Open CV

Open CV (Open Source Computer Vision Library) is a collection of algorithms for computer vision. it basics focus on real time image processing it is free for commercial and research use under a BSD license..

Tensor Flow

Tensor Flow is a mathematical computation library for training and building your machine learning and deep learning model with a simple to use high level APIs.

Keras

Keras is a neural network API. It is library written specifically in python. Also, It works with other libraries and packages such as tensorflow which makes deep learning easier. Keras was developed to allow for quick experimentation and for fast prototyping.

CNN

Convolutional Neural Network are designed to process data through multiple layers of arrays. This type of neural networks is used in application like image recognition of face recognition. The primary difference between CNN and other ordinary neural network is that CNN takes input as a two dimensional array and operates directly on the images rather than focusing on feature extraction which other neural network focus on.

The dominant approach of CNN includes solutions for problems of recognition. Top companies like google and facebook have invested in research and developments towards recognition projects to get activites done with greater speed.

A convolutional neural network uses three basic ideas:

- Local respective fields.
- Convolution
- Pooling

FACE MASK DETECTION WITH DIFFERENT ANN AND COMPARE THEM :

Artificial neural network

I am using different architecture and models of ANN were used for face mask detection. ANN can be used in face mask detection because these models can simulate the way neurons work in human brain. I comparison between different neural network for face mask recognition system and lastly we use those model which have better accuracy.

Retinal connected of neural network (RCNN)

I am presented face mask detection system based on a RCNN that examine small windows of an image to check each window contain face with or without mask. First, a preprocessing

step, adapted from, is applied to window of the image. Then window is passed through the neural network, which decides whether the window contain face with or without mask. They used the two training dataset of image. In first dataset with mask images collected by me consist of total 800 images. The second dataset without mask consist of 750 images, The recognition face with mask and without mask equal to 80% accuracy rate.

Principal Component Analysis with ANN:

I am using PCA with class specific linear projection to detect or recognized face with or without mask in a real time video stream. The system steps to search for face with or without mask in an image:

1. Select every 20x20 region of input image
2. Use intensity values of its pixel as 400 inputs to ANN
3. Feed values is forward through ANN and
4. If the value is above 0.5 the region represent a face
5. Repeat steps several times, each time on a resized version of the original input image to search for faces at different scales.

Convolution Neural Network:

In this planned method, the mask detection model is constructed victimization the successive API of the keras, library. this permits us to make the new layers for our model step by step. the assorted layers used for our CNN model is represented below.The 1st layer is that the Conv2D layer with one hundred filters and therefore the filter size or the kernel size of 3X3. During this first step, the activation operate used is the 'ReLu'. This ReLu function stands for corrected linear measure which is able to output the input directly if is positive, otherwise, it'll output zero. The input size is also initialized as 150X150X3 for all the photographs to be trained and tested victimization this model In the second layer, the

MaxPooling2D is employed with the pool size of 2X2The next layer is once more a Conv2D layer with another one hundred filters of constant filter size 3X3 and {also the} activation operate used is that the 'ReLu'. This Conv2D layer is followed by a MaxPooling3=2D layer with pool size 2X2.

In consecutive step, we have a tendency to use the Flatten () layer to flatten all the layers into one 1D layer. After the Flatten layer, we use the Dropout (0.5) layer to forestall the model from overfitting. Finally, towards the end, we have a tendency to use the Dense layer with fifty units and therefore the activation operate as 'ReLu'.

The last layer of our model are going to be another Dense Layer, with solely 2 units and the activation function used will be the 'Softmax' function. The softmax function outputs a vector which is able to represent the chance distributions of every of the input units. Here, two input units are used. The softmax function will output a vector with two probability distribution value.

Fast Neural Networks (FNN)

The proposed FNN for the face mask detection. A FNN approach to reduce the computational time for locating human faces with or without mask. Each image is divided into small sub images and then each one is tested separately using a fast ANN. The experimental result of comparison with conventional neural network showed that high speed achieved when applying FNN.

Table 1: Comparison of neural network method

s.no	Methodlogy	Recognition rate(%)
1	RCNN	90.45
2	PCA with ANN	95.67
3	CNN	95.22
4	FNN	94

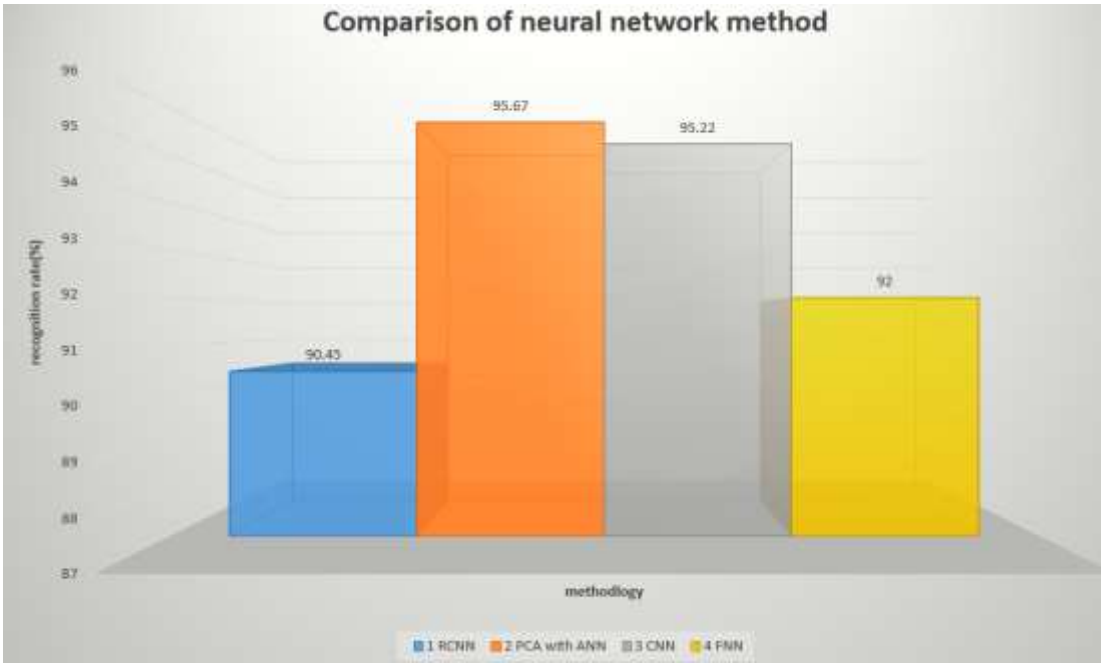

Figure 1: visualization of neural network method comparison

After the comparison the two best methodlogy is CNN and PCA with AAN both recognition rate areapproxmitely same then I am using for the CNN for the face mask detection mode.

DATA COLLECTION

The dataset pictures for covert and unmasked faces were collected from images dataset offered within the public domain the masked images were obtained from the factitious generated by me through the picture redaction tool and few from collected from the public domain. Within the data set the onsite of 800 with masked face and 750 are while not masked face. The data set is collected for the training the face mask detection model.

Figure 2: With mask image dataset

Figure 3: without mask image dataset

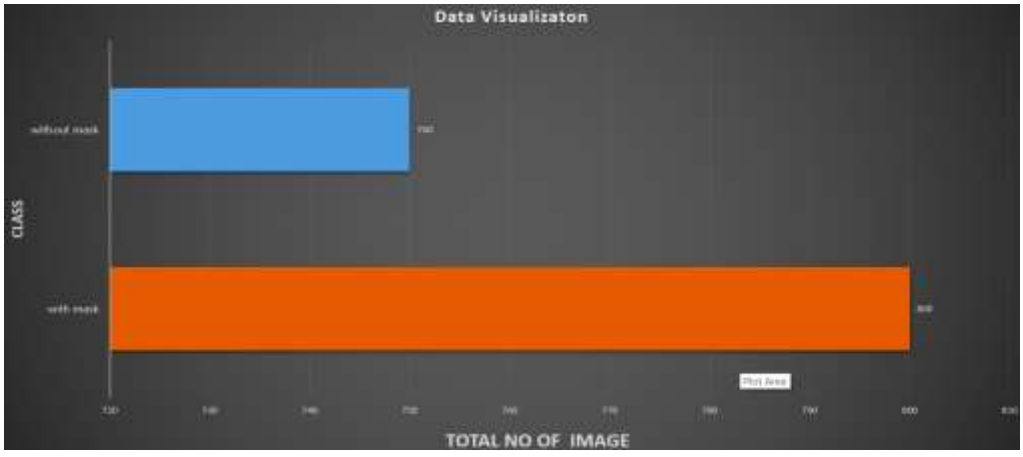

Figure 4: Data visualize

METHODLOGY

Face detection

The downside of face mask detection is all regarding face detection. However, before face mask detection is possible, on should be able to faithfully notice a face and its landmarks. This can be basically a segmentation problem and in sensible system, most of the trouble goes into finding this task. After all the particular detection supported options extracted from these facial landmarks is barely a minor step

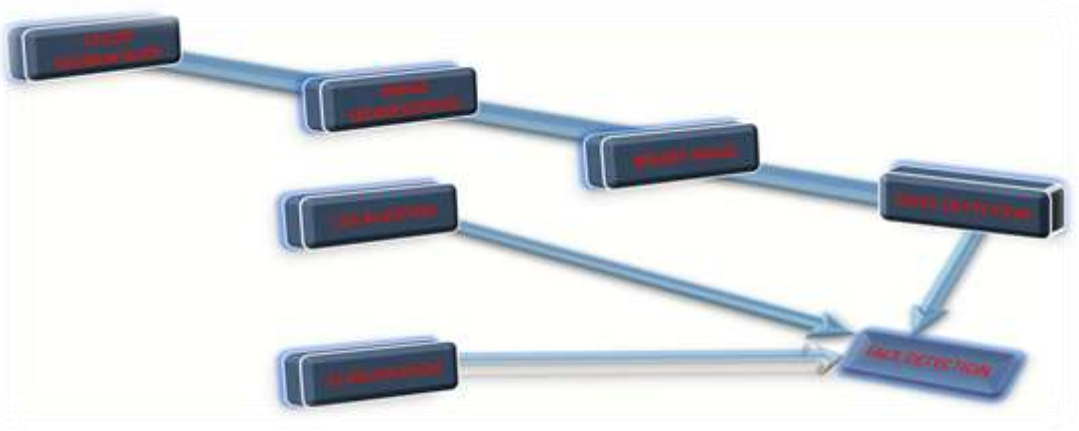

Figure 5: Steps in face detection

Figure 6: Face detect in image

Proposed System for the Face Mask Detection

The proposed system focuses on how to identify a person wearing a mask on the image/video stream. Help with computer vision and deep learning algorithm by using Open CV, tesnsorflow, Keras library.

Method:

1. Train deep learning model(MobileNetV2).
2. Apply face mask detector over images/live video stream.

Step 1. Data visualization

In the first step, let us visualize the total number of images in the dataset in these two categories. We can see that there are 800 images in the "Yes" category and 750 images in the "No" category.

Table 2

Categories	Labeled	Total image count
With face mask	Yes	800
Without face mask	No	750

Step 2. Data Augmentation

In the next step, we expand the data set to include a larger number of images for training. In this step of data expansion, we rotate and flip each image in the data set. We see that after

data expansion, we have total 2851 images of which the "yes" category contains 1430 images, and the "no" category contains 1421 images.

Number of examples: 2851

Percentage of positive examples: 50.163576881134134%, number of pos examples: 1430

Percentage of negative examples: 49.836423118865866%, number of neg examples: 1421

Step 3. Splitting the data

In this step, we divide the data into a training set, and the training set will contain the images on which the CNN model will be trained and test set and the images on which the model will be tested.

In this case, we use split_size =0.8, which means that 80% of the total images will enter the training set, and the remaining 20% of the images will enter the test set.

Table 3

Set	Labelled	Total image count
Training	Yes	1129
Test	Yes	301
Training	No	1121
Test	No	300

After segmentation, we see that the required image percentage has been allocated to the training set and test set as described above.

Step 4. Building the Model

In the next step, we will use Conv2D, MaxPooling2D, Flatten, Dropout, and dense to build a sequential CNN model. In the last dense layer, we use the " soft ax " function to output vector that gives the probability of each of the two categories.

```
+ Code  + Text

model=tf.keras.models.Sequential([
  tf.keras.layer.conv2D(100,(3,3), activation='relu', input_size=(150,150,3)),
  tf.keras.layer.MaxPooling2d(2,2),

  tf.keras.layer.conv2D(100,(3,3), activation='relu'),
  tf.keras.layers.MaxPooling2D(2,2),

    tf.keras.layers.Flatten(),
    tf.keras.layers.Dropout(0.5),
    tf.keras.layers.Dense(50, activation='relu'),
    tf.keras.layers.Dense(2, activation='softmax')
])
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['acc'])
```

Here, we use "ADAM" optimizer and "binary crossentropy" as our loss function because there are only two types. In addition, you can even use MobileNetV2 to get better accuracy.

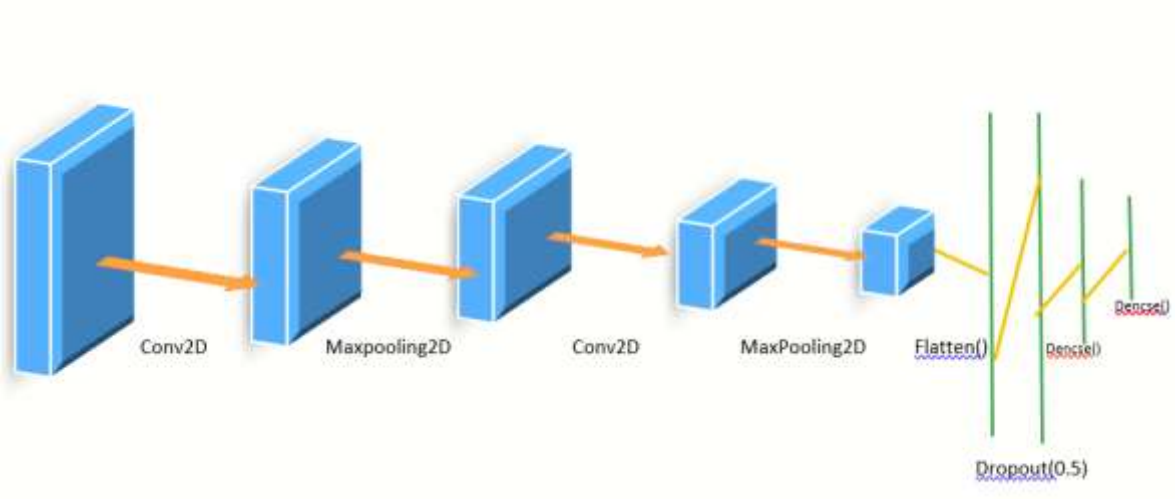

Figure 7: CNN Model for Face Mask (self)

Step 5. Pre-Training the CNN model

After setting up the model let us create"train generator" and "validation_generator" to make it fit our model in the next step. We see a total of 2250 images in the training set and a total of 551 images in the test set.

Step 6. Training the CNN model

This is the main step in which we put Images into the training set and test set to use the sequence model built by the keras library. I have trained the model for 20 epochs. However, we can train more epochs to obtain higher accuracy, so as to avoid overfitting.

```
history = model.fit_generator(train_generator,
                    epochs=20,
validation_data=validation_generator,
                    callbacks=[checkpoint])>>Epoch 20/20
220/220 [==============================] - 231s 1s/step - loss: 0.0717 - acc: 0.9710 -
val_loss: 0.0270 - val_acc: 0.9922
```

We see that after the 20th epoch, our model has accuracy of 97.86% on the training set and 99.22% on the test set. This means that it is well-trained without any overftting.

Step 7. Labeling the Information

After building the model, we label the results with two probabilities.["0" is "without mask", "1" is "with_mask"]. I also set the color of the bounding rectangle using RGB values. ["RED" stands for "without mask" "GREEN" stands for "with mask"'].

labels_dict={0:'without_mask',1:'with_mask'}

color_dict={0:(0,0,255),1:(0,255,0)}.

Step 8. Importing the Face Detection Program

From now on, we plan to use it to detect whether we are wearing a mask through the pc's webcam. For this, first of all, we need to implement face detection

Step 9. Detecting the Faces with and Without Mask

In the last step, we use the Oven CV library to run an infinite loop to use our webcam, where the cascade classifier is used to detect faces. The code webcam =cv2.videoCapture (0) indicates the usage of the webcam. The model will predict the likelihood of each of the two categories [without mask, with mask]). Based on a higher probability, tags will be selected and displayed around our face.

FLOW DIAGRAM:

Figure 8: Flow diagram for face mask detection

MobileNetV2

MobileNetV2 is predicated on the thought of MobileV1, using deeply intelligent separable convolution as an efficient building piece. However, V2 introduced two new features building:

1) Linear bottlenecks between the layers, and

2) Shortcut connection between the bottlenecks.

The basic structure is shown below

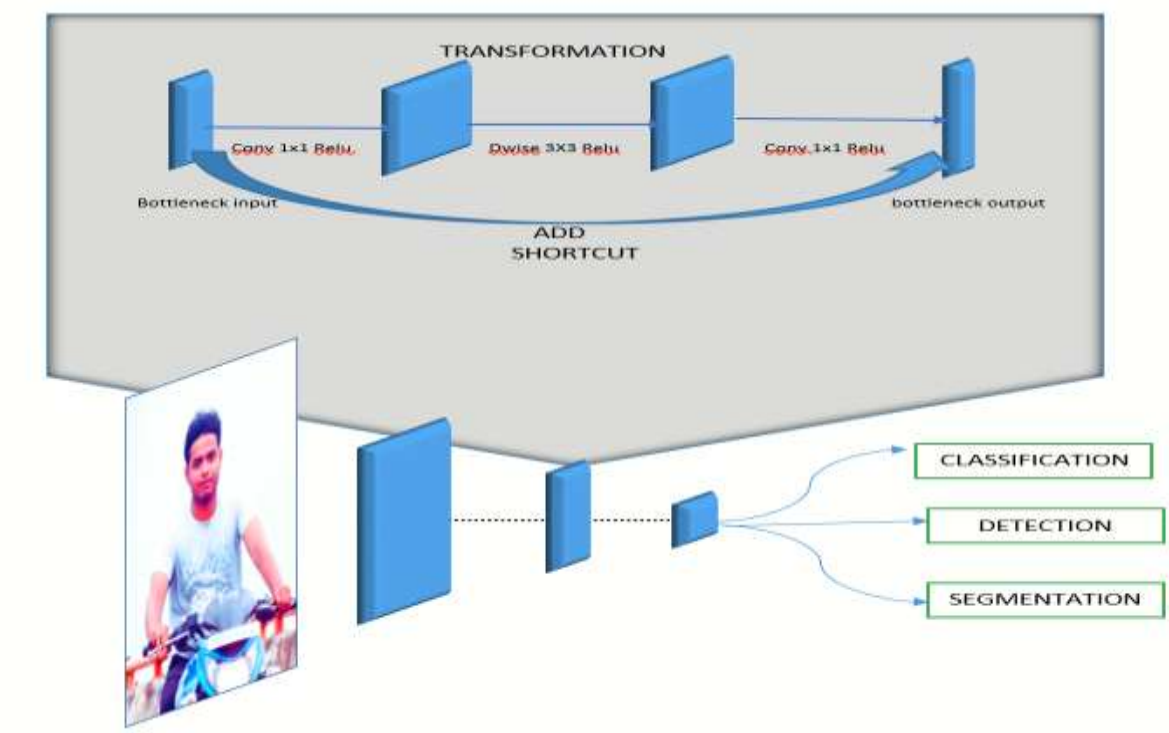

Figure 9: MobileNetV2 Building Block

A typical MobileNetV2 architecture has multiple layers below. In python, we will use the model library in tensorflow to make a MobileNetV2 model. the load of every layer within the model is predefined consistent with the Image net data set. the load indicates padding, stride, kernel size, input channel and output channel. Select MobileNetV2 because the algorithm for building models which will be deployed on mobile device. A customized fully connected layer was developed that contains for consecutive layers on top of the MobileNetV2 model.

The layers are:

1. Average Pooling layer with 7×7 weights

2. Linear layer with ReLu activation function

3. Dropout Layer

4. Linear layer with Softmax activation function with the results of 2 values

The final layer softmax function gives two result each probability represent the classification of the "mask" or "non-masked".

.RESULT

Experimental Result

The experimental result of system performance are evaluated with the MobileNetV2 classifier and ADAM optimize

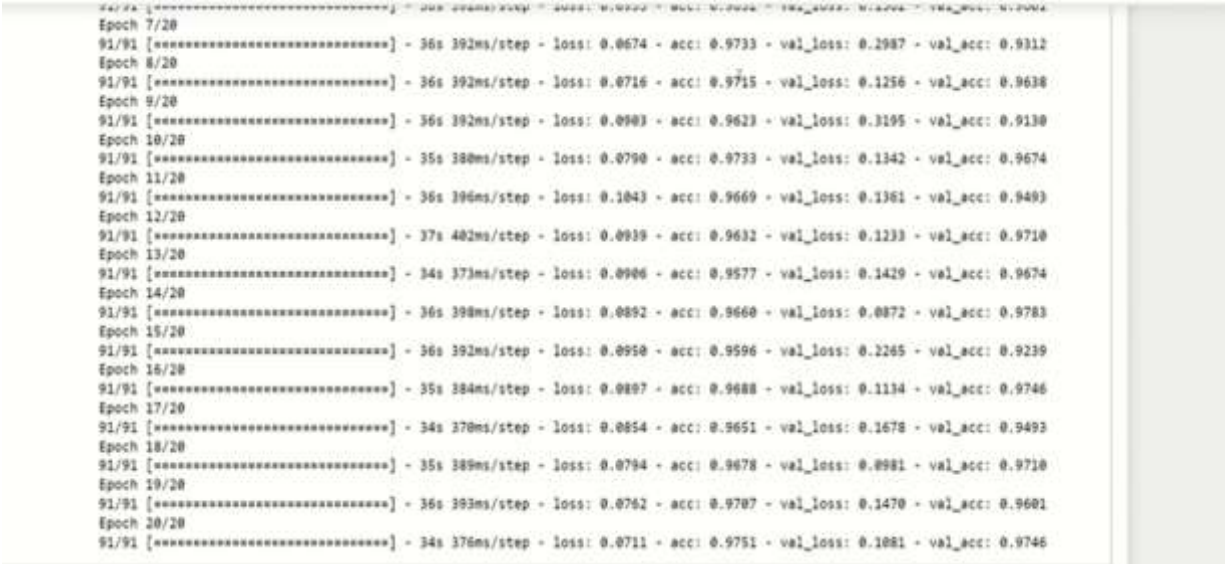

Figure 11: compilation screen for training script of face mask detection.

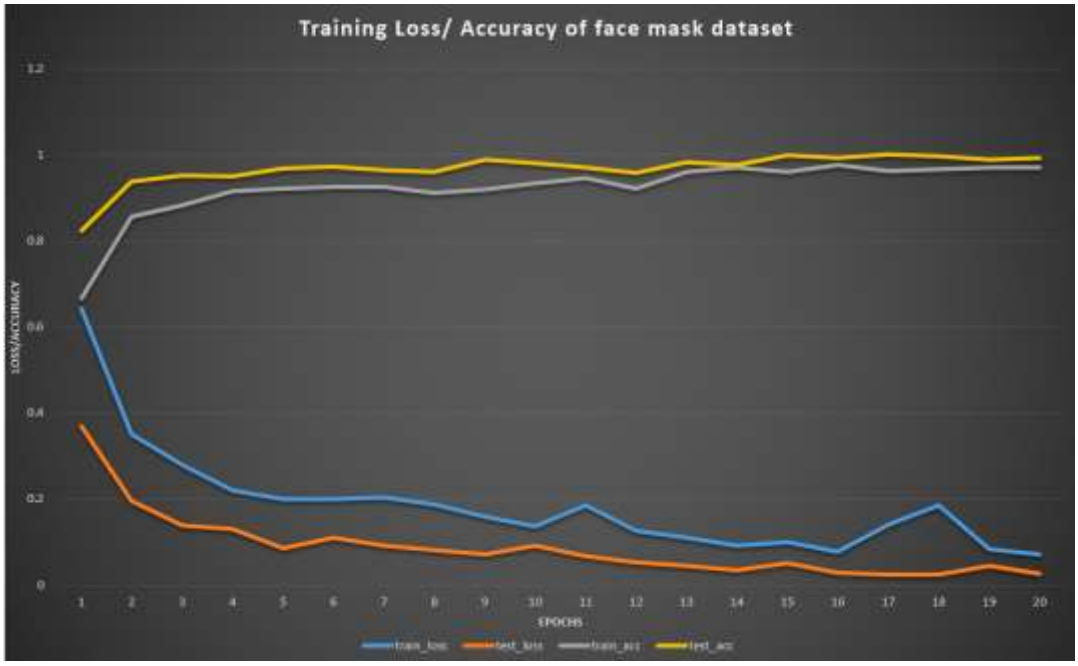

Figure 12: Training Loss/Accuracy curves of face mask detection dataset

Face Mask Classifier Performance Metrics

```
]: predict=model.predict(test_X,batch_size=BS)
   predict=np.argmax(predict,axis=1)
   print(classification_report(test_Y.argmax(axis=1),predict,target_names=lb.classes_))
```

	precision	recall	f1-score	support
with_mask	0.96	0.99	0.98	138
without_mask	0.99	0.96	0.97	138
accuracy			0.97	276
macro avg	0.98	0.97	0.97	276
weighted avg	0.98	0.97	0.97	276

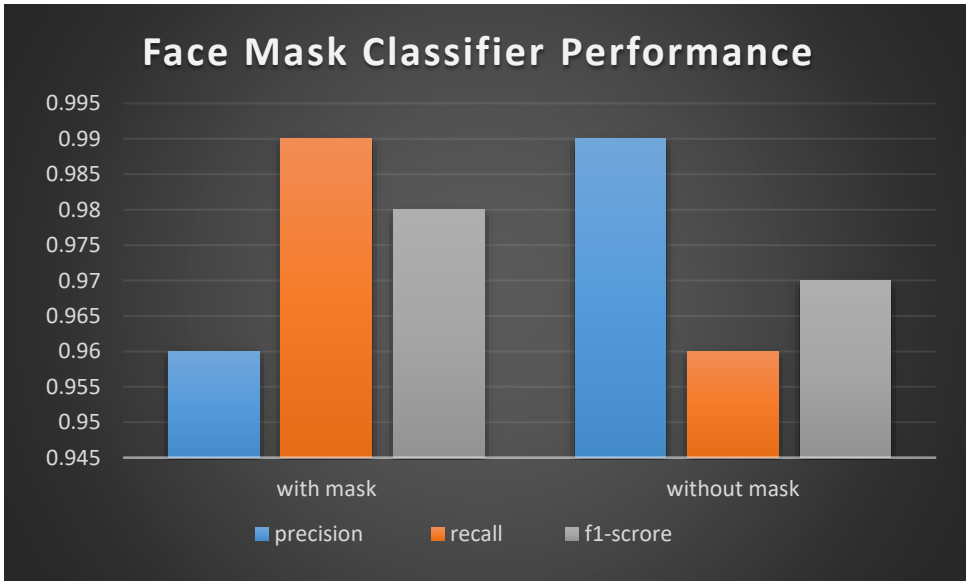

Fig 13: Performance Metrics Histogram graph

FINAL RESULT

Combining all the elements of our architecture, we tend to so get correct mask observation system. MobileNetV2 classifier employed in this system. The resultant system performance and has the potential to detect face mask in image with multiple face over a large vary angles.

Face mask detection from image :

Figure 14: Detect face with mask from image

Fig 15: Detect face without mask from image

Face mask detect from real time image:

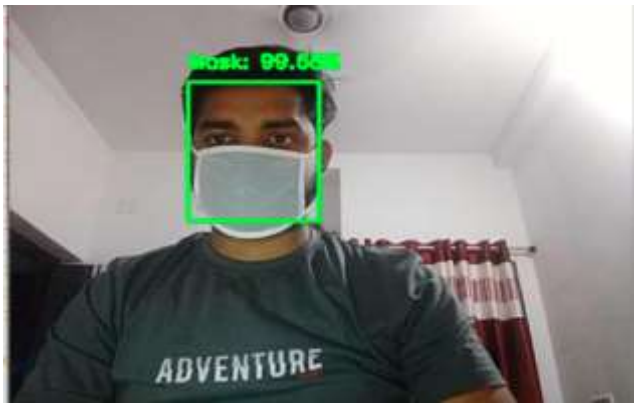

Figure 16: Detect face with mask or without mask in real time video stream

CONCLUSION

As the technology are blooming with emerging trends the availability so we have novel face mask detector which can possibly contribute to public health care department. The architecture consist of MobileNetV2 classifier and ADAM optimizer as the back bone it can be used for high and low computation scenarios. The our face mask detection is trained on CNN model and we are used OvenCV, Tensor Flow , Keras and python to detect whether person is wearing a mask or not . The model were tested with image and real- time video stream. The accuracy of model is achieved and, the optimization of the model is continuous process. This specific model could be used as use case of edge analytics

FUTURE SCOPE

The current ongoing system is gracing with MobileNetV2 classifier one of the best system which would be implemented along with the interface of alarm and alerting system in future generation. This system will be integrated with the system implementing social distancing that would make it a complete system which can bring a dramatic impact on the spread of. The new world will be well being of high demand of mask as faceless future and that will be a big security concern. Expertise say, CNN that using face mask proves to be the best solution to mitigate the spread of air borne virus like corona, but as a big security concern headed to challenge the nation as it would create a massive opportunity for people who cover their faces for nefarious reason. And also experts say the mass no of mask wearing in could complicate in crime investigation in the coming days, as facial recognition is an important part in tracking of the criminals. When the pandemic covid-19 getting over, then this system comes into play for chemical factories, bank, glass factories etc. If a person enters the bank while wearing a mask he would be not allowed to enter and also if the person does not wear masks in glass factories chemical factories and etc. then the person would not be allowed to

enter to the industry. A mind concept of human being have been proved out to be very good at recognizing familiar faces and facial recognizing familiar faces and facial recognition algorithms are getting better in identifying pattern. So thus this challenge would create a scope to new face detection algorithms which can identify aces which are covered with greater accuracies and precisions.

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