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**Abstract**

COVID-19 pandemic has rapidly affected our day-to-day life disrupting the world trade and movements. Wearing a face mask for Protection has become a new normal. Face detection and recognition will be considered as one of the most intriguing modalities for biometric models. Therefore, face mask detection has become a crucial task to help global society.For this purpose we are using some basic Machine Learning packages like TensorFlow, Keras, OpenCV and Scikit-Learn. Here, in this Project a very fast image pre-processing with the mask in the center over the faces.Our Model is trained on dataset that consists of images of people of two categories that are with and without face masks.Three levels of work that we carried out are: images preprocessing, extracting crucial part from images and image classification. Features extraction and Convolutional Neural Network are used for classification and detection of a masked person. This Method attain an accuracy of 99.1 %. .

**Keywords:** CNN, Haar Cascades, PCA, OpenCV

# 1 Introduction

Global pandemic COVID-19 circumstances emerged in an epidemic of dangerous disease all over the world. Million numbers of people getting sick in one day. This virus can be affected from human to human through the droplets and airborne.The major cause of infection from the virus was the carefulness of the peoples and lack of their consciousness. During this disaster time period everyone should raise awareness and naturally should do some oneself activities.Therefore, to protect each other, every person should wear a face mask properly when they are outdoors. It's very difficult to surveillance all the time and also time-consuming. This research mainly helps to solve this problem and help people to protect themselves. Now a day's this security system is increasing which leads to a remarkable change in our daily life. Therefore, the Security system has a crucial rule to safeguard people.

Deep Learning methods have been extremely effective and it has been widely used to build artificial intelligence in nearly every domain. convolutional neural networks have recently been successfully applied to face masks detection. By encouraging this, we suggested a system which would classify those among the crowd who did not wear a mask. This mechanism can be applied in various areas like airports, railway stations, malls and all other crowded places as a preventive measure which has a considerable importance in the current scenario.

Face mask detection involves detecting the location of the face and then determining whether it has a mask on it or not. The issue is proximate cognate to general object detection to detect the classes of objects. Face identification categorically deals with distinguishing a specific group of entities i.e. Face. It has numerous applications, such as autonomous driving, education, surveillance etc. In this project we are using a simplified approach to serve the above purpose using the basic Machine Learning (ML) packages such as TensorFlow, Keras, OpenCV and Scikit-Learn and building a system for mask face detection using several classifiers available on CNN.

# 2 Literature Survey

- Loey et al[1] have introduced the hybrid design which uses deep learning for face mask detection which has two parts. Resnet50 is used as a first part for extraction of the feature while second part used the concept of support Vector Machine, ensemble algorithm and decision trees for classification and recorded testing accuracy 99.64 percent using SVM on RMFD dataset, 100 percent on LFW dataset and 99.49 percent on SMFD dataset.
- Sabbir et al. [2] constructed the Principal Component Anal-ysis (PCA) to identify the person in a masked and unmasked face. By using extremity of the PCA they observed that wearing masks had an effect on accuracy of face resonance.
- Grassi et al. [3] proposed Data preprocessing of a quite smooth image by applying a sequentially shaded elliptical mask focused over the ears.

Used during classification in combination with DCT, for extracting functions, and RBF Neural Networks and MPL, it enables system output to be increased without altering the overall computation intensity and also decreases learning time of neural networks with MLP.

- Li et al. [4] developed an HGL methodology to overcome the major issue of head pose specification with masks mostly during endemic problem COVID-19. This method utilizes an analysis of image colour distortion as well as a line representation.
- Ramachandra et al. [5] presented An observational research on vulnerability identification and appearance attack detection employing custom 3D silicone masks leading to actual targets for commercial face recognition systems (FRS).
- Li et al. [6] suggested an innovative 3D face mask attack detection approach based on visual refractive analysis. The face picture was first analyzed in the proposed approach using an inherent picture decomposition technique to measure the image reflectance. Then, the histograms of the pixel intensities are derived from three orthogonal planes to point out the differences in intensity of reflectance images between the actual face and the 3D face mask. Afterwards, provided that a seamless surface's reflectance image was more susceptible to changes in illumination, the 1D convolutional neural network has been used to describe how various components or surfaces respond differently to illumination variations.
- In [7] the authors used PCA (Principal Component Analysis) method to identify faces with masks, which is essential in the field of security. This is one of the few works which concentrated on detection of human faces where they are wearing masks. They found that the accuracy in human face detection decreases by 70 % when a face mask is present.
- In [8] the authors have developed a method to identify how a person is wearing the face mask. They were able to classify three categories of facemask-wearing condition namely correct facemask-wearing, incorrect facemask- wearing, and no facemask-wearing. This method achieved over 98 % accuracy in detection.

# 3 Library and Packages

## 3.1 Keras

Keras is an open-source software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow library.The core data structures of Keras are layers and models.All the layers used in the CNN model are implemented using Keras.It wraps the efficient numerical computation libraries Theano and TensorFlow and allows you to define and train neural network models in just a few lines of code.

### 3.2 TensorFlow

TensorFlow can be used across a range of tasks but has a particular focus on training and inference of deep neural networks. Tensorflow is a symbolic math library based on dataflow and differentiable programming.In the proposed model, the whole Sequential CNN architecture (consists of several layers) uses TensorFlow at backend. It is also used to reshape the image in the image processing. Deep Learning models directly or by using wrapper libraries that simplify the process built on top of TensorFlow.

### 3.3 OpenCV

OpenCV is a library of programming functions mainly aimed at real-time computer vision. OpenCV is utilized to differentiate and recognize faces, recognize objects, group movements in recordings, trace progressive modules, follow eye gesture, track camera actions, expel red eyes from pictures taken utilizing flash, find comparative pictures from an image database, perceive landscape and set up markers to overlay it with increased reality.

### 3.4 haarcascade

It is a machine learning based approach which uses a lot of positive and negative images for training the classifier. Positive images contain images that we want to classify for our classifier and negative images contain of anything else that doesn't involve the entity that we want to find. OpenCV also includes several pre-trained classifiers for eyes, face, smile etc. Firstly, we loaded haarcascade frontalface default xml classifiers and after that loaded An Grayscale mode of input image. Then we have the faces throughout the image. If features are identified, the coordinates of the face region are retrieved as Rect(x, y, w, h). If we have those positions, we will be able to build a face ROI. Finally, on detected face ROI, a trained classifier is applied to determine if a person wears a mask or not.

## 4 Proposed Methodology

We used python script, tensor flow and CNN as deep learning architecture to create an efficient network for the detection of facemasks. Our purpose is to train a custom CNN model to detect if a person is wearing a mask or not. This project able to detect the mask's faces very fast from every possible angle.It takes an RGB input image from any orientation to obtaining output. The main work of this function is feature extraction and class prediction to the images.In the feature extraction system, the image get sketched and created into a new image where the image that generated is more efficient than the previous image.The Dimensionality of images get reduced in this part to an to an efficient representation.In our proposed model mask face can be detected using the webcam.Firstly the size of the input image resize 100*100 and perform feature extraction and prediction.After completing the training process

it gives us some model data with their accuracy level.later using that model we will predict the outcome using web-cam.

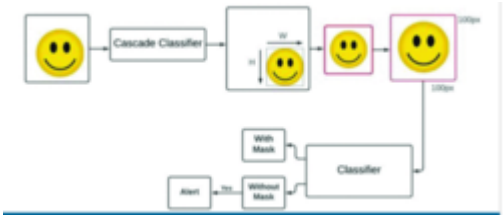


**Fig. 1** Proposed System

## 4.1 Convolutional Neural Network (CNN) Implementation

CNN is analogous to " standard" neural networks, through-out the context that they have been completely invented of hidden layers with "learnable" specifications of neurons [9]. These neurons obtain inputs, perform a dot product and then proceed with non-linearity. The entire network communicates the correlation between the raw pixels of images and their classification ratings.The CNN is a deep neural network that typically takes images as input, trains features based on bias and weights, the value of which is randomly selected technically, Every input image passes through a sequence of kernels, pooling layers, convolution layers, fully connected layers (FCs) and uses Softmax to define an image with stochastic values between 0 and 1.

- The very first layer where information is derived from an input image is Convolution .The relationship among pixels through the use of tiny squares in data input to acquire image properties is preserved by convolution.
- Pooling layers can optimize parameter counts whenever the images are all too large. The Max pooling extracted with the largest factor from the rectified function diagram. It could put on the average pooling even the largest portion. List of all Map Elements feature names as Sum pooling.

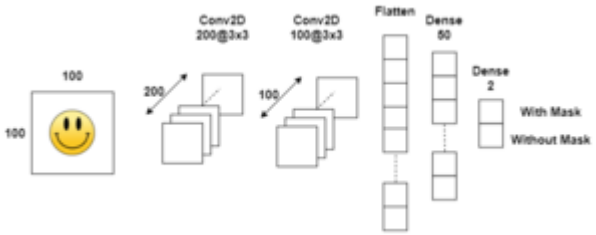


**Fig. 2** CNN Architecture

In this proposed model, four convolution layers are implemented using 16, 16, 32, 32 filters respectively with size $3 \times 3$ and Relu is used as an activation.

# 5 Result and Analysis

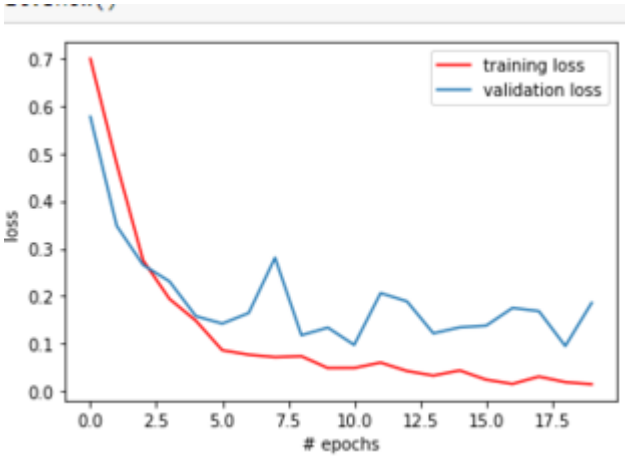


**Fig. 3** Traning and Validation Loss

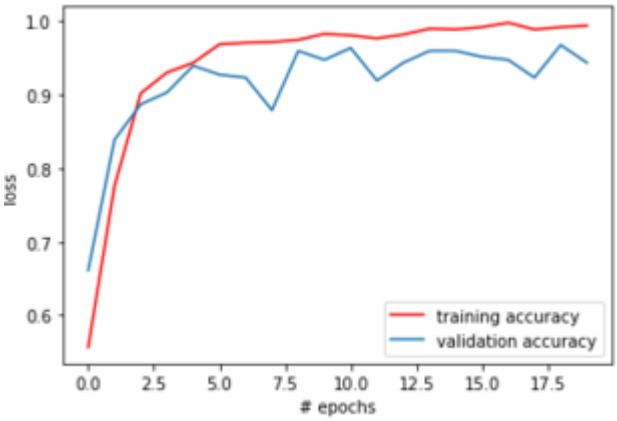


**Fig. 4** Traning and Validation Accuracy

In this work, the model is trained on Jupyter Notebook using python script with batch size 32 and Adam optimizer for 20 epochs.convolutional neural network gives higher accuracy than the rest of other algorithms, also it quite fast compares with other algorithms. Our experiment has been performed about 1,376 images(Taken from GitHub) with mask and without mask face. From


**Fig. 5** Face Detection Without Mask


**Fig. 6** Face Detection with Mask

the dataset,90 % of images were used for the training dataset and remaining 10 % dataset was used for testing purposes.our model generated higher accuracy which was 99.1 % whereas validation lost 87.5 % and validation accuracy 97.3 %.

## 6 Conclusion

This paper works along with CNN to detect masked face in a secured way and for establishing a better surveillance.The dataset that we used is quite small but it is giving the better accuracy.This system can be employed in public

places like railway stations and malls. It will be of a great help in companies and huge establishments where there will be a lot of workers.

# 7 Future Work

In future we will add more data to get more accurate result in detection. As far our resources is limited we can't get higher fps rate in video.As our project can't ensure to detect face from every angle so in the future, it can be developed to detect and work fluently from every angle. A new version of YOLOv4 also come into play recent couple of days. We will apply these models for compare the performances all of them.

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