FMNet: A novel hybrid face mask detection using deep learning

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FMNet: A Novel Hybrid Face Mask Detection using Deep Learning

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Abstract. Face Mask recognition has developed as an extremely admired issues in several domains such as image processing, computer vision and artificial intelligence. Several novel approaches are being developed through deep learning based Convolutional Neural Network model to detect the face mask identification. In this paper, we propose "FMNet" model which indicates Face Mask detection Neural Network model for recognition of face mask person on publicly available face masks images as resources. Furthermore, we applied image preprocessing, feature extraction have performed using CNN, applied FMNet model for face mask recognition from images, and finally perform classification technique to categorize the images as person "wearing masks" and "not wearing masks". Our experimental outcome generates better performance in finding face mask by achieving accuracy as 99.7%. Moreover, comparing our proposed algorithm results with pre-trained models namely VGG 16 attains 99.6%. This system has capability to perform in real time application creates it applicable to identify people in airports, buses, schools etc.

Keywords: FMNet (Face Mask Detection using Neural Network) model, Convolutional Neural Network (CNN), Neural Network (NN)

INTRODUCTION

Nowadays, the entire world is facing corona virus disease which is very pandemic. Several steps are used by citizens to monitor the spread of deadly virus. There are so many steps which are necessitating to fight against Corona disease. Face mask is one of the most important thing people have to wear which doesn't affected by dangerous covid-19 disease. Several research and investigations were performed on covid-19 disease is still going on. So as to avert the covid-19 disease from spreading, we have attempted to establish recognition of face mask framework that uses neural network model. In addition, while comparing with the existing method which detects a face using only bounding box that has no ability to segment each face from the background image. To avoid segmentation issues happened in existing approaches, we proposed novel technique especially deep learning based FMNet model for detecting face mask and categorizing the images into "with masks" and "without masks" depicted in figure 1.

The main objective of our proposed work is described as follows:

- To develop a novel hybridized face mask identifier to detect a person is wearing a mask or not.
- But our proposed model implemented using Kaggle data with generated real time data using Opencv.

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We are basically demanding to contribute the identification of certain productive method face mask with the help of advanced technology especially deep learning based FMNet model for combat beside covid-19.

FIGURE 1. Sample Image to Identify With Mask and Without Mask

ARCHITECTURES OF CNN

There are several network architectures utilized by existing researchers for detecting face mask wear by public to stop spreading from corona virus disease.

SRC Net: Bosheng Qin et. al [2] extended a novel face mask wearing circumstance detection model by means of integrating Super Resolution of image along with Classification net (SRCNetwork). This model involves preprocessing the image, recognition of faces; crop the face from image, finding super Resolution of image, and finally facial mask wearing state recognition.

Inception V3: The novel deep learning technique was introduced by Jignesh et. al [3] namely transfer learning approach automatically recognize the persons who are not wearing the masks. This model is constructed by tuning the pre-trained model namely Inception V3 applied on simulated masked face resource. Transfer learning method attains accuracy measure as 99% in detecting people wearing face mask or not.

R-CNN: The face mask detection along with segmentation approach from images was implemented using R-CNN approach named as G-mask that integrates both identifying face mask persons as well as segmentation of images into single structure aspiring to attain further information regarding face image by Kaihan Lin et.al [6]. Also, this method used ResNet 101 to mine the relevant features from images to point out the objects via pixels.

ResNet50: Face mask detection was identified by using both machine learning as well as deep learning model as a hybrid model presented by Loey et. al [7, 9]. This method mainly focused on feature extraction to remove the irrelevant features initially though ResNet50 model and then applied machine learning algorithms such as support vector, decision tree and ensembling method for better classification of images into with masks and without masks.

YoloV3: Face mask detection was implemented using YoloV3 network by Bhuiyan et. al [10] based on deep learning technique for human being protection which is applicable in real time concert relating with prevailing GPU. Yolo network were utilized during implementation of face mask detection done by said et. al [7].

Google FaceNet: The importance of face masks presented by Sabbir Ejaz et. al [11] particularly accuracy improvement in detecting dissimilar facial masks. Initially, the face mask portions were detected on images via pixels through multi task CNN model. Consequently, the face features on images were extracted using Googl FaceNet model. At last, machine learning algorithm like support vector were applied for classification process.

VGG 16: Meenpal et. al [13] utilized this VGG 16 network model for feature extraction which attains the accuracy as 93.8%.

NOVEL APPROACH FOR THE PROPOSED WORK MODULES

In this section, we are discussing about the modules put forth for identifying an individual/ personality wearing mask or not focusing on the way of preventing from Covid-19 since Corona virus disease is a highly dangerous.

The proposed work was implemented using five modules which are specified as below and the proposed architecture for face mask recognition is depicted in figure 2.

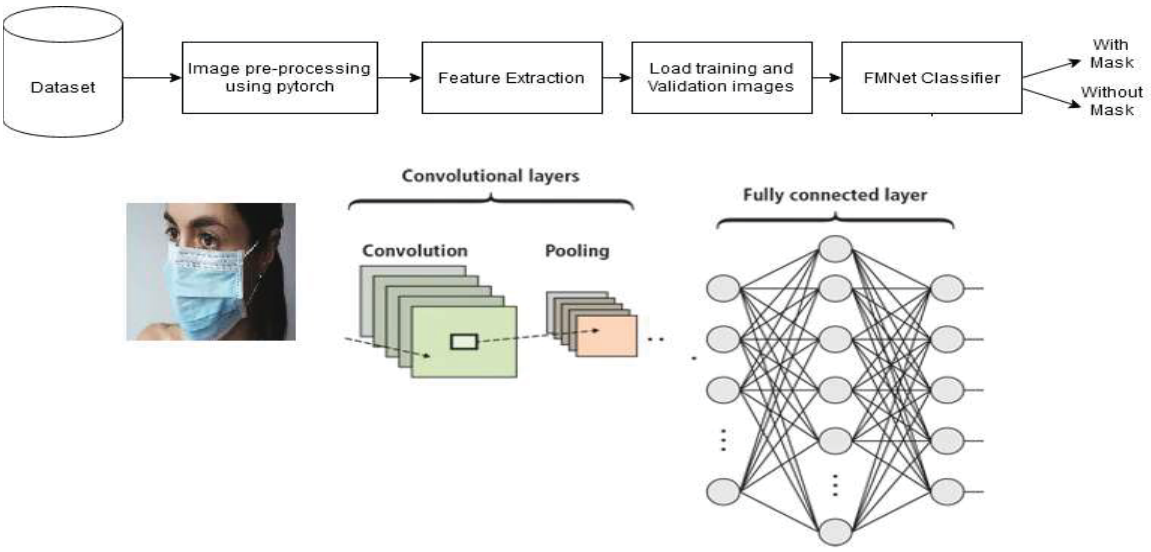


FIGURE 2. Proposed Architecture for the Face Mask

Image Generator

The first and foremost step is to envisage the total number of images that has been gathered from datasets which has two groupings namely with masks and without masks images shown in table 1.

TABLE 1. Quantity of images used

Groupings	Number of images used
With masks	10,000 images
With no masks	10,000 images

Image Data Processing

Image preprocessing technique suggests that raw information does not yield sufficient accuracy if applied to any classification methods, which can be confirmed from the results we achieved. Our purpose is to demonstrate how much the accuracy differs with the implementation on some simple Convolution networks of some well-known preprocessing methods. The following steps were demonstrated to process the image for detecting face mask or not.

Step 1: Detect the person wearing a mask or not in real time

Step 2: Derive list of images with mask and without mask

Step 3: Create a numpy array placeholder for grayscale image

Step 4: Convert images into array

- For each mask and no mask image
- Rescale the size of image
- Flip the image in horizontal and vertical position
- Resize the height and width of image
- Change the shear and zoom range
- Save the data

Step 5: Scale the images as arrays

Feature Extraction Using CNN

In our detection method, we are utilizing six layers to construct the mining of distinctiveness for every CNN as follows and shown in figure 3.

Input layer: Here the size of image as 28*28.

Layer1: The number of Convolutional filter is six which has image size as 24*24.

Sub layer 1: The number of Convolutional filters in sub sampling layer 1 is six along with convolution map size as 12*12, kernel size as 2*2.

Layer2: In this second layer, the image size reduced to 8*8, filter size as 5*5.

Sub layer 2: The image size is convoluted as 4*4, filter size as 2*2, quantity of kernel as 6.

Layer 3: Convoluted image size as 1*1, quantity of filters is six which has filter size as 4*4.

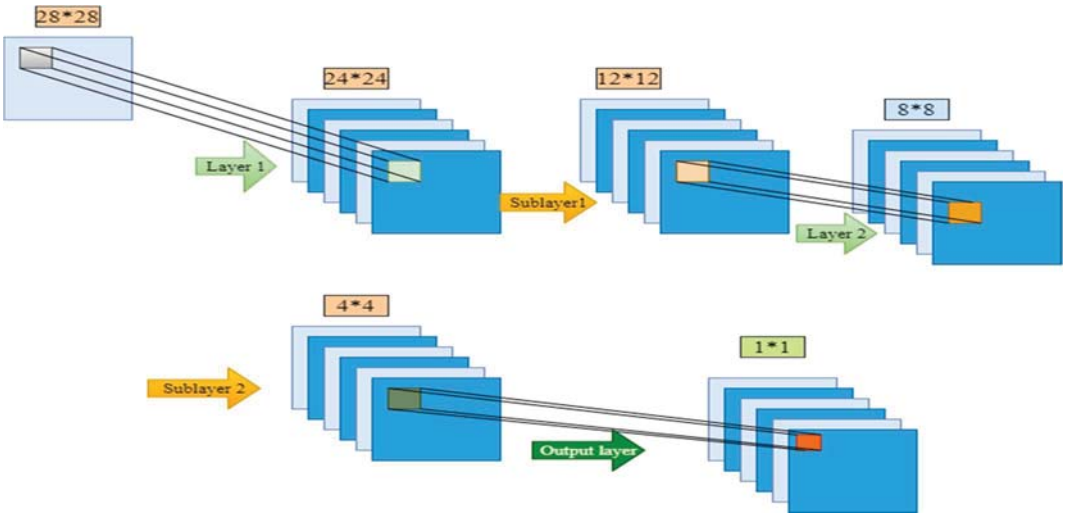


FIGURE 3. Face Image Size Segmented Using CNN

Dataset Sketch

The images were gathered from publicly available resource details shown in table 2.

TABLE 2. Dataset source

S.No	Dataset Acquisition (Source)
1.	https://www.kaggle.com/andrewmvd/face-mask-detection

DISCUSSION AND INVESTIGATIONAL OUTCOMES

Feature Extraction from Images

The feature extraction is similar to image preprocessing technique to extract the relevant features through pixels on images for further classification.

Image Segmentation

Now, the images are segmented into two categories namely region based and edge based segmentation for identifying the faces wearing masks.

Region Based Segmentation

Pixel values are utilized to partition the background of image as well as particular objects from the image. The object or image background in the threshold segmentation may be categorized based on pixel values dropping below or above the threshold value. If the value of the pixel is larger than our fixed threshold, then it is mentioned as object, otherwise it is a background. The region based segmentation on images using CNN is revealed in figure 4.

FIGURE 4. Region based segmentation using CNN

Edge Based Segmentation

In this part, we are discussing about detection of objects specified as pixels from images using edge based detection method given in figure 5. An image's discontinuous local characteristics are known as an edge. Edges have established an object boundary and described the shapes of multiple objects that are present in a given image.

FIGURE 5. Edge based segmentation

We are utilizing kernel for detecting objects on images both horizontal edges and vertical edges. The used kernels for object detection on images specified in matrix format are mentioning in table 3.

TABLE 3. Edges along with kernel used

Edges	Kernels used
Horizontal edges	[[1 2 1] [0 0 0] [-1 -2 -1]]
Vertical edges	[[-1 0 1] [-2 0 2] [-1 0 1]]
Laplacian	[[1 1 1] [1 -8 1] [1 1 1]]

Then we are applying Laplacian kernel is an edge sharpen filtering method in which the Laplacian operator has ability to detect the edges on face image consequently the face images are smoothening (i.e) finding noises as well as edges on the image. After Laplacian filtering has applied, the convoluted image as in figure 6.

FIGURE 6. Convoluted Image after Laplacian Filter

K-Means Clustering Technique

This clustering technique were applied for extracting the relevant features from an input images via grouping similar data as one cluster and distinguishing dissimilar points in another cluster. Here, k represents the number of clusters in the image. The following are the steps to perform k-means clustering algorithm, the image after extracting features using k-means shown in figure 7.

1. Determine the centers of the clusters
2. Derive the points based on the distance of the each cluster
3. The points are rearranged based on the nearest cluster.
4. Derive new points from newly formed clusters.
5. Repeat steps (4), (5) and (6) until either the center of the clusters does not change.

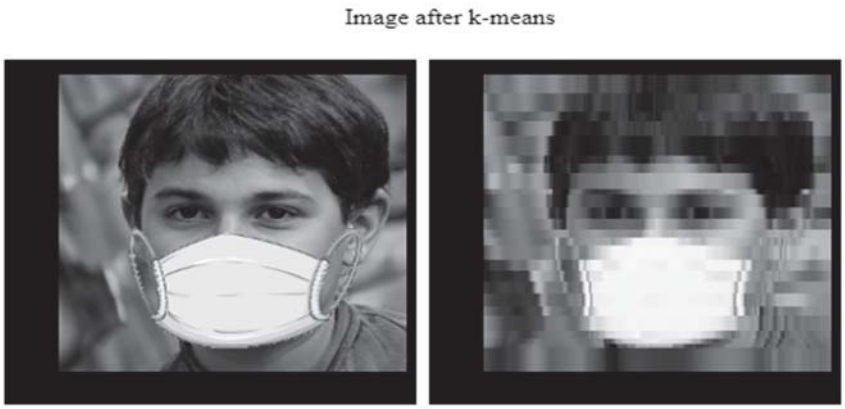


FIGURE 7. Face Mask Image after K-Means

FMNet Classifier

In this section, the images are distinguished as person "with masks" and persons "without masks" using Face Mask Detection using Neural Network model. The extracted face images are passed into each layers in CNN sequentially are described in table 4.

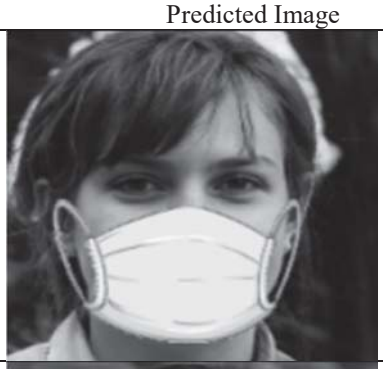
TABLE 4. Layers in CNN with size

Layers in CNN	**Image size**
Convolutional 2D layer	(16,3,3)
Activation layer	(150, 150, 3)
Max_pooling layer 2D	(2, 2)
Convolutional 2D layer	(32, 3, 3)
Max_pooling layer 2D	(2, 2)
Dense layer	512
Output layer	1

Classification

The images were categorized into persons "with mask" and "no mask" is depicted in table 5.

TABLE 5. Category of image along with predicted output image

Category/ Labeled	Predicted Image
Wearing mask	
Not wearing mask	

Metrics Evaluation

Accuracy is the measure for finding the performance of our proposed model in face masks detection as well as classifying the images into wearing masks and not wearing masks.

Comparison among Pre-Trained Model with the Proposed Model

The pre-trained model used VGG-16 achieves validation accuracy as 99.6% but the proposed FMNet model produced better validation accuracy as 99.7% shown in table 6 and figure 8.

TABLE 6. Comparison with pre-trained model

Model	**Training Accuracy**	**Validation Accuracy**
Proposed FMNet Model	98.41	99.7
VGG-16 Pre-trained Model	98.1	99.6

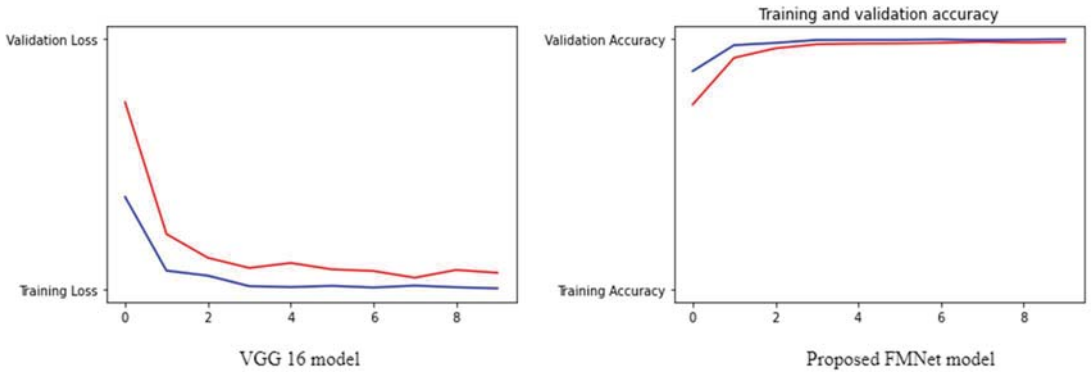


FIGURE 8. Training accuracy Vs validation accuracy

CONCLUSIONS

As the expertise is flourishing with emerging trends, we have a new facial mask method that can contribute probably to the division of public health. Hence we proposed novel deep learning based network namely "FMNet" model for facial mask recognition. For our investigation, we gathered face images available on publicly, then preprocessing images to find the objects on images, feature extraction, and then applied FMNet network model for face mask detection, consequently classification method were performed for distinguishing an individual "with masks" and "without masks". The facial mask recognition is trained on CNN model as well as we utilized OpenCV, TensorFlow, Keras, PyTorch and python to identify that public person is wearing mask or not. This model was analyzed with images only. Finally the metrics measures such as accuracy were evaluated to predict the overall performance of model in face mask recognition. The accuracy attained using FMNet model is 99.7% which is better while comparing with pre trained model namely VGG 16 model. This novel approach will be suitable for face mask detection as a real time application in public places such as airports, hospitals, schools, park, markets, museum, stadium etc.

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