SMART FACE MASK DETECTION USING CONVOLUTIONAL NEURAL NETWORK

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Abstract : The Covid-19 outbreak has turned into a global issue in the medical field. This virus spreads from person to person through the droplets of infected individuals. Public areas have the highest transmission risk, according to the WHO using a face mask is one of the greatest strategies to prevent infection. Lockdowns had to be implemented by governments all around the world and face masks are made compulsory as prevention purpose in reaction to the Covid-19 outbreak.The method that is suggested in this study uses Convolutional neural network algorithm for face mask detection. Libraries such as the TensorFlow, OpenCV and Keras are being used.

The trained model applied in this research generates an accuracy score of 0.94 and with F1 score of 0.95 in the training set. For future developments, this approachable model can be combined with a number of already-available technologies, including face detection, facial expression recognition and biometric authentication.

Index Terms - **Machine Learning, CNN algorithm, Face mask detection, TensorFlow, Covid-19.**

I. INTRODUCTION

The coronavirus illness (COVID-19) is now recognised by the World Health Organization (WHO) as an infectious disease. The illness is caused by SARS-COV-2, also known as severe acute respiratory syndrome [1]. People who have this SARS-COV-2 virus suffer from mild to severe respiratory illnesses. While some patients might only need a certain type of therapy, those with few symptoms might recover swiftly without it. At very high risk are people who have diabetes, heart disease, chronic respiratory conditions, or are elderly. There were approximately 63.9 lakh fatalities worldwide and 57.1 crore total deaths up till July, 2022. 5.26 lakh fatalities and 4.39 billion incidents in India have been recorded to date. The United States has suffered the most damage out of the 228 nations affected. To far, there have been three COVID waves in India, marked by abrupt rises and falls in the number of cases. When an infected individual speaks, coughs, sneezes, or inhales, the SARS-COV2 virus can be transferred from the mouth or nose in minute liquid droplets. If someone is close to an infected person or touches a contaminated surface, they could become infected by inhaling the virus. In a busy environment or a closed space, the infection may spread quickly. Therefore, the government has issued certain rigorous regulations to prevent the spread of lethal viruses, such as wearing masks that are correctly fitted, keeping a physical distance of at least 1 metre from others, even if they do not appear unwell, and often washing your hands with sanitizer. In this study, it is suggested a CNN algorithm that seeks to identify face masks. The proposed algorithm can be combined with various safety models so as to keep a check on people wearing mask or not. Given these factors, the suggested model will unquestionably contribute to ensuring people's safety and wellbeing.

II. RELATED WORK

Face mask detection has achieved substantial advancements in the disciplines of computer vision and face recognition [16]. Face detection models were built using a range of methods and algorithms. The proposed method in this research uses TensorFlow, Keras, OpenCV, and deep intelligence to recognise face masks. This strategy can be used in defence because it is inexpensive to implement. This method does have an F1 rating of 0.93 and a precision score of 0.9264.

The RPi approach and the Haar Cascade technique were used to find the low-cost Internet of Things [2]. In this system, contemporary access control technology is employed. The assignment is completed fast and [1]with a high detection rate using a machine learning method that makes use of the haar cascade in the OpenCV library. [1] Face recognition is a technique for identifying and verifying someone's identity by looking at their face.[1] Python programming can be used to modify the framework. A coloured image of the faces can be distinguished from a grey one by the pro-positive style.[1] The accuracy of the framework is evaluated using the facial recognition rate for each individual in the database[1]. Deep learning methods are used to integrate facemask detection with alarm systems for physical separation, as discussed in [3], [4]. The researchers created a highly precise method for recognising

facial masks using semantic segmentation, fully convolutional networks, gradient descent, and binomial cross-entropy. The accuracy and speed of variety recognition were enhanced using CNN[16]. The many cultivars of Durio zibethinus, or more commonly known as durian, were categorised using the visual structures of the crop[16]. The Internet of Things was used to build pulse oximetry kits (IoT) [6], [7],[1] technology as tools for monitoring covid-19 patients remotely via cell phones in terms of physical and social distancing practises. Protocols based on body temperature were also utilised.[1]

The "CNN-based Mask Detection System Using OpenCV and MobileNetV2" method is one that this study suggests. [8] finds face masks efficiently by utilising deep learning frameworks, the TensorFlow, Keras, and OpenCV libraries. The trained MobileNet model, which is detailed in this work, generated an F1 score and an accuracy score of 0.99 in the training set[20][21][30]. This user-friendly approach can be combined with a variety of currently accessible technologies, such as face detection, biometric authentication, and facial expression detection, to make future advancements.[21]

The paper on face recognition by P. Gupta, N. Saxena, M. Sharma, and J. Tripathi (2018)[14] proposes a novel method of using a deep neural network (another type of deep network). Instead of using raw pixel values as input, this proposed method just uses the retrieved facial features. The Haar Cascade is used to extract facial features, and these facial features are fed in place of the raw pixel values. The neural network-based recognition framework's complexity has decreased together with the quantity of redundant input information. By employing DNN instead of Convolutional Network, the procedure is also simplified and speed up. The correctness of the framework is not jeopardised by the suggested strategy, since the average accuracy obtained is 97.05% [4].

The proposed system by R. Bhuiyan, S. Khushbu, and S. Islam (2020)[10] displays faces using the state-of-the-art YOLOv3 architecture and attempts to identify masks. Uses the Convolution Neural Network learning method is You Only Look Once (YOLO) (CNN). By connecting with CNN through research, simple algorithm retrieval, and the usage of hidden layers, YOLO is able to find and detect any form of image. During model execution, 30 different images from the dataset are first entered, and the results are subsequently merged to produce action-level predictions[17].Both excellent imaging and detection results are produced by it. This model is used to a live video in order to determine its detection performance with masked and unmasked two layers as well as its frame rate inside the video.[22] Our model produces amazing results inside of video, with an average frame rate of 17.[22] Comparing this system to other ones that use their own data set, it is more effective and quicker.

III. METHODOLOGY

3.1. FACE MASK DETECTION:

In this paper, a deep learning technique called Convolution Neural Networks (CNN)is utilised to recognise face masks. Developed for analysing organised arrays of data, such as images. CNN is a deep learning neural network. Each layer of a CNN applies to some distinct set of various filters, and it is mostly used for image analysis and recognition. [20]A CNN is a type of artificial neural network that is specifically designed to understand pixel input. A final result is produced by combining thousands of filters, and the output is then forwarded to the neural network's next layer.[20]
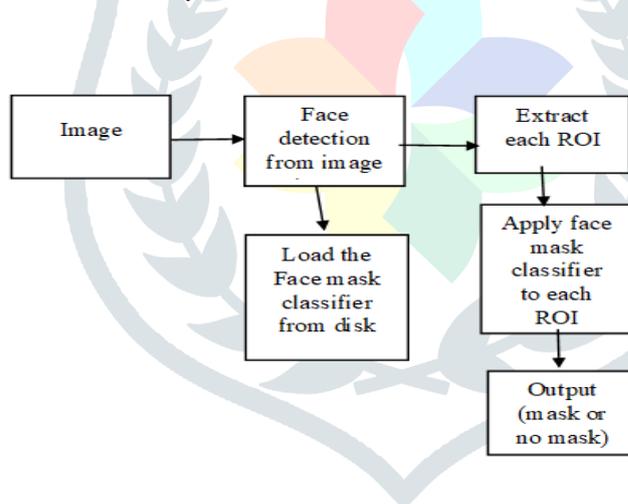

Fig 1. Block diagram of face mask detection

The face mask detection method evaluates the suggested framework using the TensorFlow software library [20], as shown in Fig 1. Keras and TensorFlow are used to train the mask detection model.[16] The following lists the steps that make up the algorithm.[16]

Step 1: Collection of data

Step 2: Pre-Processing of data

Step 3: Splitting of data

Step 4: Training model

Step 5: Testing/Evaluation of the model

As previously said, all the data and elements needed to form the networks are gathered from numerous categories. All of the dataset and elements needed to form the network are gathered from various categories in accordance with the aforementioned algorithm. [1]The next stage is to train and test the set once the initial dataset is available. [1]Only the network's performance is

evaluated using this test dataset. The neural network should undergo further training to learn to recognise various categories within the provided labels. The dataset should then be assessed and contrasted with the real-world labels.Face mask classifier is then applied to the region of interest (ROI), which has been extracted. The result is that the output has been created. The classifier is trained using a large number of both positive and negative images in the Haar Cascade technique, which is based on machine learning. Positive images - These pictures include the pictures that we want our classifier to be able to recognise. Negative Images - Pictures of everything else, excluding the object we're trying to find. In this case, a trained Haar cascade model is being utilised to find faces.

3.2. DATASET COLLECTION:

The images used to train and test the model came from the internet and some real-world photos taken using a mobile device. 1350 photographs total in this [1] dataset are split into two classes: 680 with masks and 670 without, as seen in Fig. 2. We selected a different set of 150 photographs with masks and 150 images without masks to test the model. This dataset was produced using regular shots of people's faces that were then altered with face masks using a specially created computer vision Python application. [1] Face-specific landmarks allow users to easily deduce the locations of face features such the mouth, jawline, eyes, nose, and eyebrows. The dataset of faces wearing masks can then be constructed using facial landmarks. Start with a photo of a person who is not wearing a face mask, then use face detection to calculate the bounding box region of the face in the photo.[30] After figuring out where the face is in the image right now, it can capture the face Region of Interest (ROI) and use facial landmarks to identify the placement of the mouth, eyes, nose, and other features.[1][29] First, a mask picture must be created. The mask will then be applied to the face automatically using landmarks on the face, notably the areas around the mouth and chin. The process is then repeated for each of the input photographs, and the mask is scaled and twisted before being fitted on the face.[1]

With Mask   Without Mask

Fig.2. Dataset of people wearing mask and without mask

The image showing people wearing and not wearing masks is used to capture the face and create the blob [1]. The network is used to extract the extracted blob's face, and the extracted detection's trust (or likelihood) is connected to the extracted detection as well.[1] [29] The extracted face is passed via the mask detection model after pre-processing to identify whether or not the sent face is donning an appropriate face mask. The weak detection is filtered to ensure that the confidence (probability) is greater than the minimum degree of reliability. Next, the extracted face is switched from BGR format to RGB format and formatted to 4 x 224.

IV. PERFORMANCE PARAMETERS
4.1 EVALUTION PARAMETERS:

The tests are conducted using the recall metrics, accuracy Precision, F1-score, and the corresponding macro average and weighted average, with the goal of illustrating the potential utility of the system.Utilizing these measures its its goal is evaluating the system from many angles.

Recall and precision show how well the model can identify genuine positives. Recall takes into account both the model's accuracy in identifying false positives and false negatives. False positives, in this case when using a mask to detect faces. False negatives happen when a face is missed in the initial detection phase because it has covered parts that make classification challenging.

An overall evaluation of the system's performance is provided by the F1-score, which combines precision and recall (into a single value), with 0 denoting poor performance and 1 denoting the highest possible performance (all cases detected correctly).The weighted average establishes an average measure of all the experiments while taking into account the amount of observations for each class, whereas the macro average metric might provide a general picture of the average of all the experiments. [22] In the case that a class receives a higher score, the final weighted average score will not be impacted by this; rather, each score will be assigned a value of importance based on the number of observations.

By classifying both classes when taking into account these characteristics, it is hoped to confirm the method's robustness.

Based on the number of true positives (TP), true negatives (TN), false negatives (FN), and false positives (FP) as stated in Equations (1) to (5), the usual assessment metrics named as accuracy, recall (sensitivity), precision, F-measure, and specificity are determined.

$$Precision = TP / (TP + FP) \qquad (1)$$
$$Recall = TP / (TP + FN) \qquad (2)$$
$$Accuracy = (TN + TP) / (TN + TP + FN + FP) \qquad (3)$$

F-measure = (2 × *Precision* × *Recall*) / (*Precision* + *Recall*)   (4)
Specificity = *TN* / (*TN* + *FP*)   (5)

4.2 SYSTEM REQUIREMENTS:

The training was conducted on a device running the 64-bit version of Windows 11 with an 11th Gen Intel(R) Core(TM) i5-1155G7 @ 2.50GHz clocked at 2.50GHz and 16 GB of RAM.. The language for creating applications is Python 3.7.8. Using the Tensor-flow platform and Keras as the backend, [1]the model was created and trained. Using the training Python script, the mask detector model input dataset is created, and MobileNetV2 is enhanced[1][29]. A training history plot.png with accuracy/loss curves is also created, as seen in Figures 3 and 4.
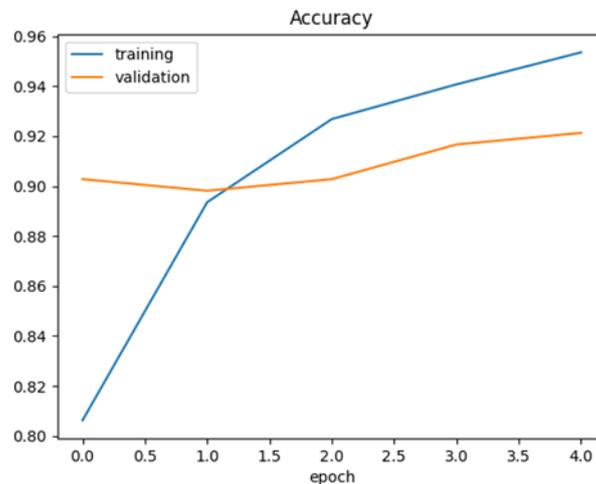

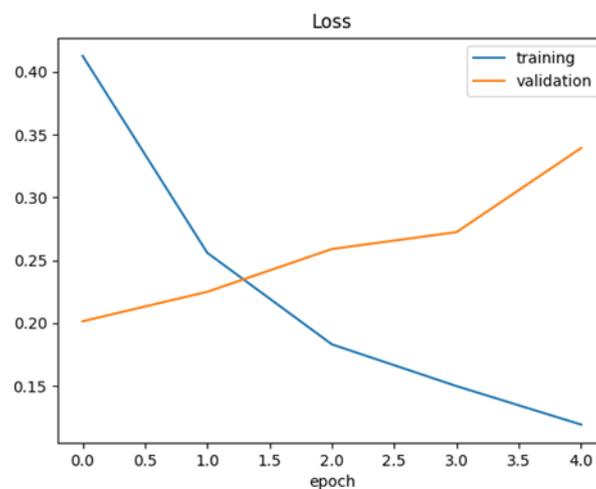Fig 3. Training Accuracy graph(Y- axis) Vs. number of epoch(X-axis)

Fig 4. Training Loss graph(Y- axis) Vs. number of epochs(X- axis)

4.3 QUALITATIVE ANALYSIS WITH DIFFERENT TEST CASE:

By altering the weights and learning rate of neural networks, optimization methods strive to minimise training losses. Figures 3 and 4 shows validity accuracy diagrams in relation to consistency and loss of validity versus loss of training as optimization factors were introduced to the analysis. More hidden layers are added to provide a deeper analytical model, but the processing difficulty increases as the number of levels increases. As additional neurons are added to each layer, processing costs will increase. To increase the quantity of data samples, it is usual practise to apply magnification, pre-processing, shears, and other picture augmentation features.[1][29].Images with these attributes are produced by deep learning model training when these parameters are applied.

An epoch is the complete set of possible inputs. The weights are updated and tested against a following cycle simulation using the same dataset, much like when building model weights after each epoch (named as next epoch). When this is run, it is assumed that [1] the entire training data set is in the main memory because keeping larger datasets in main memory for extended periods of time is impracticable, refer runtime equations. The epoch (dataset) is broken up into batches, each of which is loaded into main memory and executed sequentially.[1][29] The results are then joined together and the final interpretation is represented as an epoch output.

V.   RESULTS:
5.1. RUNTIME EQUATIONS WITH EPOCHS OF FACE MASK DETECTIHON ALGORITHM:

Epoch 1/5
999/1000 [===========================>.] - ETA: 0s - loss: 0.4193 - acc: 0.7988Epoch 1/5
1000/1000 [============================] - 171s 171ms/step - loss: 0.4193 - acc: 0.7989 - val_loss: 0.2211 - val_acc: 0.8981
Epoch 2/5
999/1000 [===========================>.] - ETA: 0s - loss: 0.2294 - acc: 0.9036Epoch 1/5
1000/1000 [============================] - 37s 37ms/step - loss: 0.2293 - acc: 0.9037 - val_loss: 0.1662 - val_acc: 0.9259
Epoch 3/5
999/1000 [===========================>.] - ETA: 0s - loss: 0.1628 - acc: 0.9331Epoch 1/5
1000/1000 [============================] - 41s 41ms/step - loss: 0.1629 - acc: 0.9330 - val_loss: 0.1735 - val_acc: 0.9398
Epoch 4/5
999/1000 [===========================>.] - ETA: 0s - loss: 0.1354 - acc: 0.9459Epoch 1/5
1000/1000 [============================] - 44s 44ms/step - loss: 0.1353 - acc: 0.9459 - val_loss: 0.1664 - val_acc: 0.9583
Epoch 5/5
999/1000 [===========================>.] - ETA: 0s - loss: 0.1133 - acc: 0.9555Epoch 1/5
1000/1000 [===========================] - 42s 42ms/step - loss: 0.1133 - acc: 0.9555 - val_loss: 0.1830 - val_acc: 0.9352

5.2 VALIDATION/ACCURACY:

Table 1. Validation /Accuracy of face mask detection algorithm.

	Precision	Recall	F1 score	Support
With mask	0.94	0.95	0.95	139
Without mask	0.95	0.94	0.94	131
Accuracy			0.94	270
Macro average	0.94	0.94	0.94	270
Weighted average	0.92		0.94	270

VI.   CONCLUSION:

    The major benefit CNN has over its predecessors is that it recognises important qualities automatically and without human interaction. Therefore, CNN would be a wonderful way to solve computer vision and picture categorization issues. Create features from the photographs in order to employ a different approach. After that, input those features into a classification method like KNN, logistic regression and SVM etc. These algorithms are less intelligent than CNN. Figs. 3 and 4 shows the [1][29]testing results from visual representation through accuracy and loss. The test results for the model's 94% accuracy in identifying persons wearing face masks are shown in Table 1.The suggested model can be combined with readily available devices such as biometric authentication, face detection etc.

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