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Face Mask Detection using MobileNetV2 and OpenCV

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ABSTRACT
Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. The best way to prevent and slow down transmission is by staying at least 2 meters apart from others and wearing a properly fitted face mask. The use of face masks is mandatory as per World Health Organization (WHO) guidelines to avert the spread of CORONA virus. Presently the inspection of people with/without masks is being done manually and visually by sentries/guards present at entry/exit points. Guards/Sentries cannot be stationed at every place to keep a check on such people. In this work, efforts have been made in inspecting people with/without masks automaticallywith the help of Computer vision and Artificial Intelligence. This module detects the face of the individual and identifies whether he/she is wearing a mask or not. The rectangular bounding box is drawn on the face which is displayed on the camera to detect whether the individual is wearing the facemask or not. The face mask detection in the work is performed by using the deep learning model MobileNetV2 and OpenCV and an accuracy of 99% is achieved.
Keywords—COVID-19, Face Mask, MobileNetV2, OpenCV

1. Introduction

COVID-19 is an infectious disease that has spread across 188 countries in less than 6 months [1]. The virus spreads through close contact with the infected person. WHO has advised sanitizing hands, maintaining a minimum 2 to 6 meters distance, and wearing face masks as prevention measures to reduce the widespread of the virus. Several public service providers only permit usersto use the service if they wear masks and adhere to safe social distancing. As a result, identifying face masks and keeping an eye on safe social distances are essential to combat virus outspread. Presently the inspection of people with/without masks is being done manually and visually by sentries/guards present at entry/ exit points. Guards/Sentries cannot be stationed at every place to keep a check on such people who remove their masks and roam around without restraint once they have been scrutinized at the entry gate.
Advancements in Artificial intelligence, computer vision, and deep learning technologies can help the healthcare system in detecting whether a person is wearing a mask or not. Convolution Neural Network (CNN), a type of Deep Neural Network (DNN) which are most frequently used in image classification and recognition and can be used to build a real-time face-mask detection system. The Modern deep learning model can be used to build robust models which can cover aspectssuch as detection, tracking, and validation. This paper presents a deep-learning model to detect face masks. The architecture is trained efficiently using deep learning on a dataset that has images of individuals' faces with and without a face mask. The proposed model can be implanted in surveillance cameras in businesses, educational institutions, organizations, shopping malls, multiplexes, etc., and it helps to check whether people are wearing face masks. If a person is not wearing a mask it helps to identify them and alerts higher authorities as well as notify the individual. With the help of this model, it is easy to stop the spread of viruses when the individuals are close enough within the proximity of the camera.

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To recognize faces from video streams, a pre-trained model of MobileNetV2 architecture is used in this work. The model is trained and tested using a standard dataset consisting of images of human faces with and without masks. A variety of packages of machine/deep learning methodologies and image processing techniques are used in addition to the OpenCV framework.
Recently many works in literature have been conducted on detecting the face mask. Some of the works are as follows Jignesh et al., [2] proposed face mask detection by fine-tuning the pre-trained deep learning model, InceptionV3. The work achieved an accuracy of 100%. Chavda et al., [3] presented a dual-stage face mask detection architecture. The first stage comprised a pre-trained RetinaFace model for stable face detection and for the second stage, theNASNetMobile model was used. The work reported a precision of 99.70%. Ieamsaard et al., [4] presented a deep learning-based face detection model using YOLOV5, and an accuracy of 96.5% was achieved in the study. Goyal et al., [5] compared the performance of DenseNet-121, MobileNet-V2, VGG-19, and Inception- V3 against their proposed model for face mask detection. Convolution Neural Network layers (CNN) were used along with this, libraries such as OpenCV, Keras, and Streamlit. The work used static and real-time videos as input. The study reported that the proposed work provided better results than the pre-trained model. Kumar et al., [6] presented a hybrid deep learning and machine learning model for mask detection. The study reported an error of only 1.1%. Jayaswal and Dixit [7] proposed a face detection system using single Shot Multiboxdetector as a face detector model and a deep Inception V3 architecture (SSDIV3) to extract the pertinent features of images and discriminate them in mask and without masks labels. Pham et al.,
[8] proposed an improvised YOLOv5s-CA face mask detection model for categorizing between people wearing or not wearing masks. Thus it can be seen works in the literature have used deep learning models as they can work on large data effectively.

2. Methodology

This section presents the dataset used for the work and the methodology employed.

A. Data collection and data preparation

The dataset is collected from the Kaggle data repository. The dataset consists of total of 3833 images of which 1915 is images with mask and 1918 are without mask [9]. The sample images of the dataset with mask and without mask are shown in Fig.1 and Fig.2. The data collected (image format) is converted to the uniform size of 224 X 224 pixels. Then these images are converted into arrays by using the image-to-array converter. The obtained images having the labels in the alphabetical value are converted into the numerical value i.e., 0's for those without a mask and 1's for those with mask images by using the label binarizer technique and then converting them into the NumPy array. The data set is split into two categories training and testing. 80% of the data is used for training and 20% of the data for testing.

Fig. 1. Sample Images of Datset Without Mask

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Fig. 2. Sample Images of Datset With Mask

B. Proposed Work

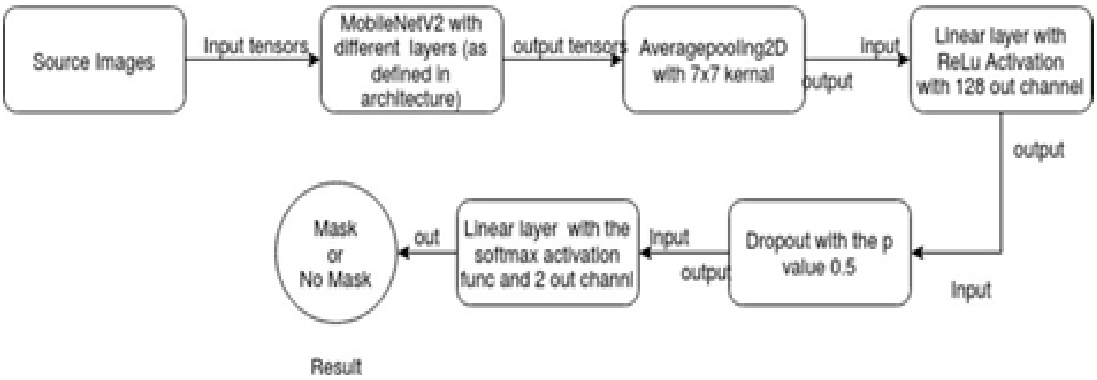

Fig. 3. Framework of the proposed approach

Fig.3 presents the framework of the proposed approach. The dataset consists of images with masks and without masks. The image from the dataset is resized to 224*224*3 dimensions and used as input to the system. The first layer contains a convolution layer that is frozen and it is replaced by MobileNetV2 which is the base model and uses ImageNet weights. The output of the base model is given as input to the head model. And for the fully connected layer base modelinput and head model outputs will be taken. The input image is processed as an array then it is inputted to MobileNetv2. MobileNetV2 is faster when compared to CNN because it uses the lesser parameters. The average pooling with a 7*X*7 kernel is applied to the network and then givenas an input to the linear layer and the rectified linear unit (ReLU) activation function is used. ReLU is the goto activation function for the non-linear use cases. The dense layer has 128 neurons with the ReLu activation function. The output of this layer is fed into the dropout layer where 25% of neurons are randomly dropped to avoid the overfitting of the data into the model. Dropout with a p-value of 0.5 is employed. The learning rate of the neural network is set to 0.0001. The optimizer used is the Adam optimizer. The model is fitted with the training generatorand trained with a batch size of 32 for 20 epochs. The output is obtained using the softmax activation function because the work is on binary classification. The final layer softmax function gives the result of two probabilities each one representing the classification of "with-mask" or "without-mask". Matplotlib is used to view the output. And by using the training loss theaccuracy is checked in the epochs.

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Finally, the application detects the face with and without a mask with the help of a deep learning model. OpenCV and Keras library functions are used.
OpenCV mainly focuses on face detection. The face will be predicted using the FaceNet and the mask will be predicted using the MaskNet and then the frame is the image that is generated every second. The face will be detected in the rectangular box-like start-x and start-y, end-x, and end-y to predict the faces on the x and y axis of the rectangle. If the person is wearing the mask then will appear like "Mask" in green color and will appear like "No-mask" in red color if the individual is not wearing the face mask with BGR (blue, green, red color). The face mask detection model on webcam is a combination of a face detection model to identify the existing faces from camera feeds and then run those faces through a mask detection model.
Identify the Face in the webcam : To identify the faces a pre-trained model provided by the OpenCV framework is used. The model is trained using web images.
Identify Mask in the webcam : Then identified face is used for detecting for face mask using the above-proposed approach.

3. Results and Discussion

The experiments are conducted by dividing the dataset into 80% training and 20% testing. The performance of the proposed approach is evaluated using accuracy, precision, recall, and F-score measure. Table.I present the results of the proposed approach for binary classification of detecting whether the person is wearing a mask or not. From Table.I it can be seen that an accuracy of 0.99, precision, recall, and F-score of 0.99 is achieved by the proposed work.

Table I. Classification performance of the proposed approach.

	Accuracy	**Precision**	**Recall**	**F-score**
With mask	0.99	0.99	1.00	0.99
Without mask	0.99	1.00	0.99	0.99

Fig.4 and Fig.6 show the sample result of detecting a person with or without a mask. Fig.4 displays that person is wearing a mask using green color with accuracy. Similarly, Fig.6 displays that person is not wearing a mask using red color with accuracy. Fig.5 shows the results of detecting a person with a mask and a person without a mask with 100% accuracy.

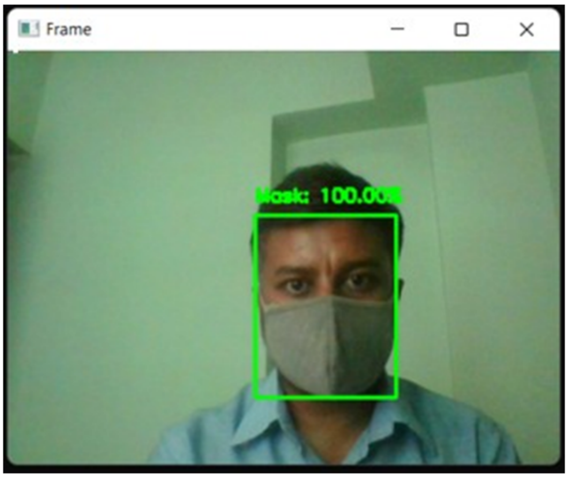

Fig. 4. Sample Result of detecting a person with a mask

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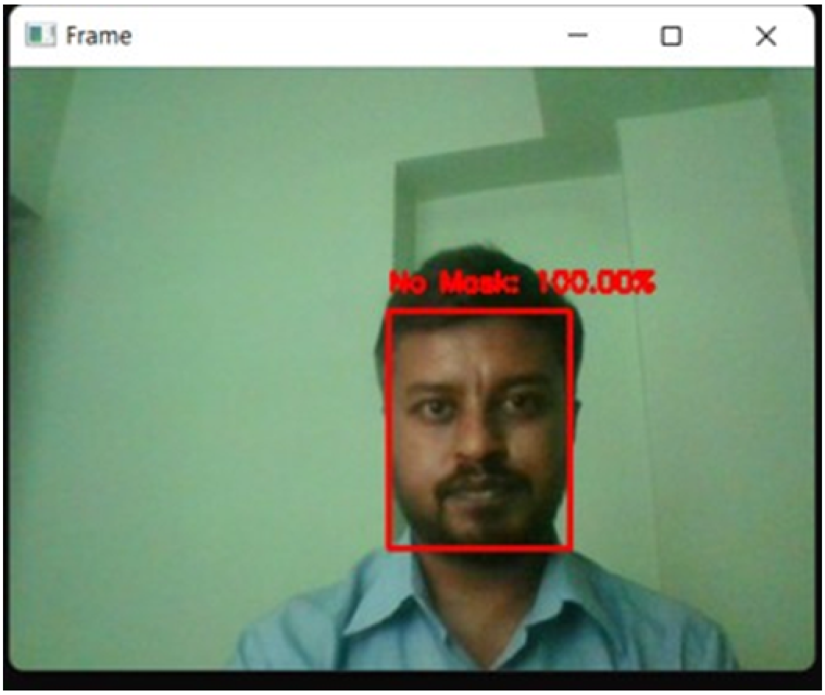

Fig. 5. Sample Result of detecting a person without a mask

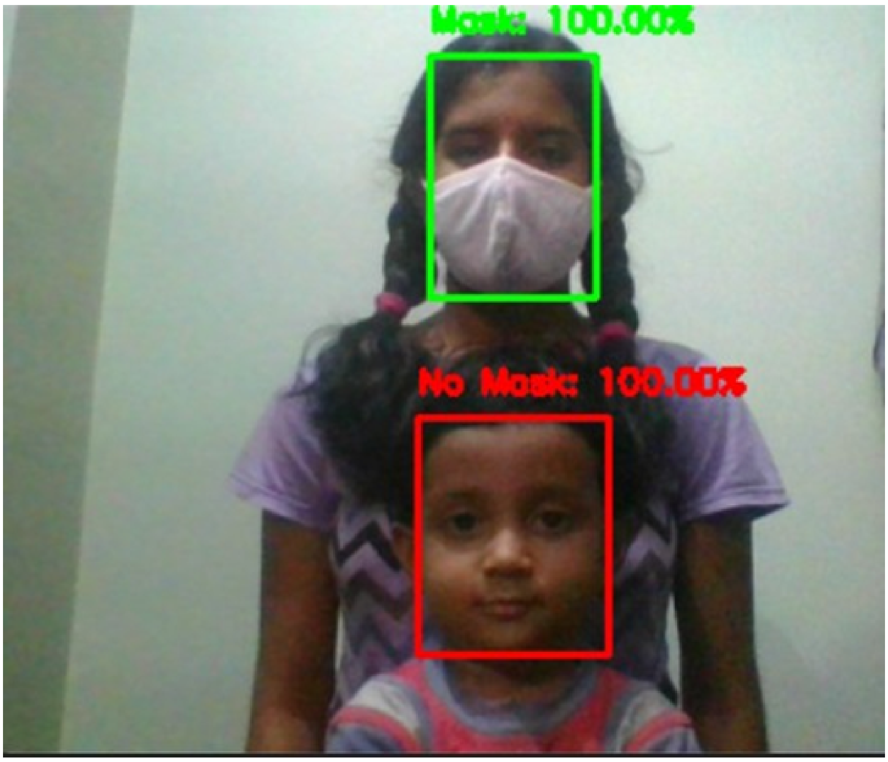

Fig. 6. Sample Result of detecting a person without a mask and a person with a mask

CONCLUSION

Wearing a face mask is one of the preventive measures to combat the spread of the COVID-19 virus in public places. An automated face mask detection system is presented in this paper using MobileNetV2 and OpenCV. If the person is identified by the camera that he/she is not wearing the face mask it will be indicated in red color showing "NO MASK" with the percentage of accuracy,if a person is wearing a mask it will be indicated with green color showing "MASK" with the percentage of accuracy. The percentage keeps on changing due to the new image will be loaded into the image and gives the percentage of results. Thus it can be concluded that the work accurately detects people with masks and without a mask with an accuracy of 99%.

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