# Facemask Detection With an Alarm System and Email Notification Using Deep Learning to Prevent Spread of COVID-19

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**Research Article**

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# Abstract

COVID-19 is one of the most dangerous viruses which caused a pandemic in human life, not only in terms of direct casualties but also regarding socio-economic impact. The outbreak quickly spread around the world. The 1st anniversary of the global Corona virus pandemic gets passed away in 2021, but still, no way to tell how long the pandemic will continue. After analyzing a report by WHO of covid-19, to minimize the rate of covid-19 transmission, our national government advised citizens to wear face masks. A model using deep learning and MobileNetV2 for face mask detection is presented. This method was trained and checked on the real-time dataset. There are 3,833 images in the Medical Masks Dataset, including 1918 images of people wearing no mask and 1915 images of people wearing masks. We adopted OpenCV to detect faces in real-time from a live stream captured with our webcam. With the aid of computer vision and deep learning, we hope to classify whether or not the person in the video stream is wearing a face mask. If the camera captures a face without a mask an Email notification will be sent out to the administrator and the system alarm will ring.


# 1. Introduction

COVID-19, a pandemic disease caused by Severe Acute Respiratory Syndrome Corona virus 2, is currently affecting the entire world (SARS-CoV-2) [1] According to the world health organization; COVID-19 is primarily transmitted from person to person by respiratory droplets. There are micrometer small covid-19 particles which always thrown out of our mouth while speaking, singing, coughing, etc. We observed even after vaccination has started in India then too Corona virus cases are increasing. According to the World Health Organization's Corona virus situation survey, over 124 million people are infected with the disease in 213 countries, killing over 2.73 million people worldwide as of March 23, 2021. India is now ranked third in the world for the number of cases of infected Corona virus. It has been reported that it has 11.5 million infected people and 160 thousand killed people. A mask acts as a shield to keep the respiratory droplets from getting into the hands of others. When worn over the nose and mouth, studies show that masks minimize the spray of droplets [2]. Many developed and developing countries around the world have made wearing a mask mandatory while leaving the house or going to public places. Face masks are also used in a variety of industries. Every location, such as Pharmaceutical companies, cement plants, chemical plants, hospitals, while cleaning, construction areas, contaminated and polluted areas, and so on, was restricted by the government. Staff must wear a face mask to protect themselves from toxic substances at work (coughing, wheezing, and shortness of breath, chest tightness, or trouble breathing, for example)[3].

Observing the global crisis, a new need for face mask identification has emerged. It is one of the technologies capable of detecting and checking the identity of an individual wearing a mask [4]. This paper presents an accurate face mask detection system using Deep Learning. It can specify whether a person on real-time video captured by webcam is wearing a face mask or not. It can also detect people who are not wearing a face mask by sounding an alarm or sending an email warning to police, authority, or an observer. This system allows them to see who isn't wearing a mask on their faces.

## 2. Related Work

According to [7] Human faces are difficult to model because there are so many factors that may alter, such as facial expression, lighting conditions, orientation, and partial occlusions like shades, scarves, and masks. Face detection can be accomplished in two ways.

Image-based approach and Feature-based approach. The author in [2] applied an image-based approach for face detection and performed this task on a dataset that contains a mask and no-mask images. According to the author [5], MobileNetV2 expands on MobileNetV1's concepts by using depth-wise separable convolution as a building block. V2, on the other hand, adds two additional architectural features: 1.Shortcut connections between the bottlenecks and linear bottlenecks between the layers. MobileNetV2 has been used at the place of convolution neural networks [5, 6]. The authors were able to create a VGG-16 model for facemask detection that is both precise and fast. They also observed physical distancing between peoples [3]. Deep learning algorithms try to take advantage of the uncertain structure in the input distribution to find good representations, often at multiple levels, with higher-level learned features described in terms of lower-level features[5].

Madhura and Ninad [8] have previously begun work on a deep learning system that categories image as a mask or no mask. They used Face-masknet Classifier to train their model with 98.6% accuracy. In [7] the method is designed for checking the correct wearing of face protection from a video selfie. They used Haar-like features to detect the face.

## 3. Dataset

The dataset has been taken from Kaggle and few open-source image libraries and Google images some of the shows in figure 1 and figure 2. There are 3833 photographs in this dataset, divided into two categories:

- With mask photographs: 1915
- Without mask photographs: 1918

Figure 1 shows with the mask folder contain all the images of people mask-wearing on their faces. Figure 2 shows are without mask folder contains all the images of people with no mask on their faces.

## 4. Incorporated Packages

Computer Vision, OpenCV, Tensor flow, Keras, Jupyter notebook, MobileNetV2.

## 5. Proposed Methodology

The project Face mask detection has been achieved by adopting the Deep Learning technique and MobileNetV2 Architecture. We have designed our project into three phases:

a. Data Preprocessing.

b. Training face mask detector.

c. Implementing face mask detector.

First, we used a suitable algorithm to train the mask and non- mask images. After the model has been conditioned, pass it on to the loading mask detector, which can detect and identify each face.

## Data Preprocessing

Data preprocessing is a method for converting unclean data into a clean dataset. Data preprocessing entails converting data from available format to another format that is more user-friendly, desirable, and meaningful [5].

Figure 3 shows the data preprocessing part, we converted all the images from the folders “with mask” and “without a mask” into arrays so that with those arrays we created a deep-learning model.

1. Looping over the image path (With mask and without mask folder).
2. Resizing the input images uniformly to (224 x 224).
3. All the photographs in the dataset are visualized as “with mask” and “without a mask”. Initialized data and labels, labels are in alphabetical order so by using label binarizer to covert the data to numeric numbers (0, 1).
4. Converting all images into an array by using the img_to_array function. This img_to_array function comes under keras. Preprocessing. Image module.
5. Appending the pre-processed input image. Finally converting them into NumPy array.
6. Splitting the training and testing data.

## Training of Model

Building the Model using MobileNetV2 Architecture:

After the input image is processed as an array we send the data into the MobilenetV2 and then we do max pooling on the same data and then flatten it to create a fully connected layer that gives the output.

MobilenetV2 is faster than Convolution Neural Network. MobilenetV2 also uses fewer parameters. The weights of each layer in the model are predefined based on the Image Net dataset. The padding, strides, kernel height, input channels, and output channels are all represented by weights. MobileNetV2 was selected as the algorithm for creating a device-deployable model. On top of the MobileNetV2 model, a customized fully connected layer with four sequential layers was created. The layers are 1. Average Pooling layer with 7,7 weights 2. Linear layer with ReLu activation function 3. Dropout Layer 4. The final

layer softmax function gives the result of two probabilities each one represents the classification of “Mask” or “No Mask”. [5] Image data generator creates many images with the help of a single image by changing properties of that image which later used for layer training, we use Adam optimizer to optimize the result. The image data generated before is flown to train the existing training data. Later we predict the output by evaluating the network using Numpyarray.

Here specified three hyperparameter constants which include my initial learning rate to 1e-4, number of training epochs to 20, and batch size to 32, these data are taken at such a lower rate to get better accuracy. We optimized MobileNetV2 with a mask/No mask dataset and attained a classifier that is **99% accurate**.

## Implementing face mask detector

1. Load face mask trained model and Caffe model to detect faces in video.
2. To identify the face/faces using OpenCV by collecting real-time data through a webcam.
3. Now the real-time data (frame/sec) we collected from the webcam to classify it using a trained model to predict the output of the given real-time input.
4. As an output we get the frame in which if a person wearing a mask it shows “Mask” with a rectangle of green color on his/her face and if a person is not wearing a Mask it shows
5. “No Mask” with a rectangle of red color on his/her faces particularly.
6. If in case a particular person is not wearing a mask so the system automatically generates an Email to notify the administrator and also rings the alarm system to prevent the carelessness of not wearing a mask.

# 6. Result And Discussion

After successfully training, implementing, and testing the code following output was obtained. The accuracy and iteration curves were plotted. Figure 4 depicts the training loss and accuracy plot. The method attains 99% accuracy (shown in figure 4).

Screenshots of the outputs have been displayed ahead. Figure 5 depicts that when a person is wearing a facemask the system indicates that particular person is wearing the facemask. Figure 6 depicts that when a person is not wearing a facemask the system indicates that particular person is not wearing the facemask and tells that person to kindly wear the facemask. Successfully implemented alarm system in case of a particular person not wearing the mask so the system automatically generates Email to notify the administrator and also rings alarm system to prevent carelessness of not wearing a mask.

# 7. Conclusion

This paper manuscript represents a deep learning model to detect if a person is wearing a face mask or not. We adopted OpenCV, Keras, tensor flow, and mobilenetV2 to specify whether people were wearing face masks or not. The model is tested with photographs and real-time video streams. The accuracy rate of detecting a person with a mask is 99%. This model was built using MobileNetV2 architecture. Successfully built alarm system to alert a person who didn't wear masks and implemented an Email notification system to notify respected authorities. This system can prevent the spread of covid-19. This framework may be used as an example of edge analytics. This system could be implemented in Cement Industries, Chemical Plants, Hospitals where the chance of spread of disease, and at airports to detect travelers without masks.

# 8. Future Works

In the future, I thought to add up some extension to this project

1. To count the number of objects who aren't wearing the mask and notify them using email to the observer

2. To increase the accuracy and quality so that the current model can work with high definition camera this is established there on the traffic signals and nearby to the road to observe traffic.

# 9. Declarations

**Funding:** Not Applicable.

**Conflict of Interest:** The authors declare no conflict of interest regarding the publication of this research paper.

**Availability of data and material:** Not Applicable.

**Code availability:** All the experiments have been performed using OpenCV, Keras, tensor flow, and mobilenetV2.

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# Figures


**Figure 1**

Depicts images of the human wearing a mask.


**Figure 2**

Depicts images of human not wearing a mask.

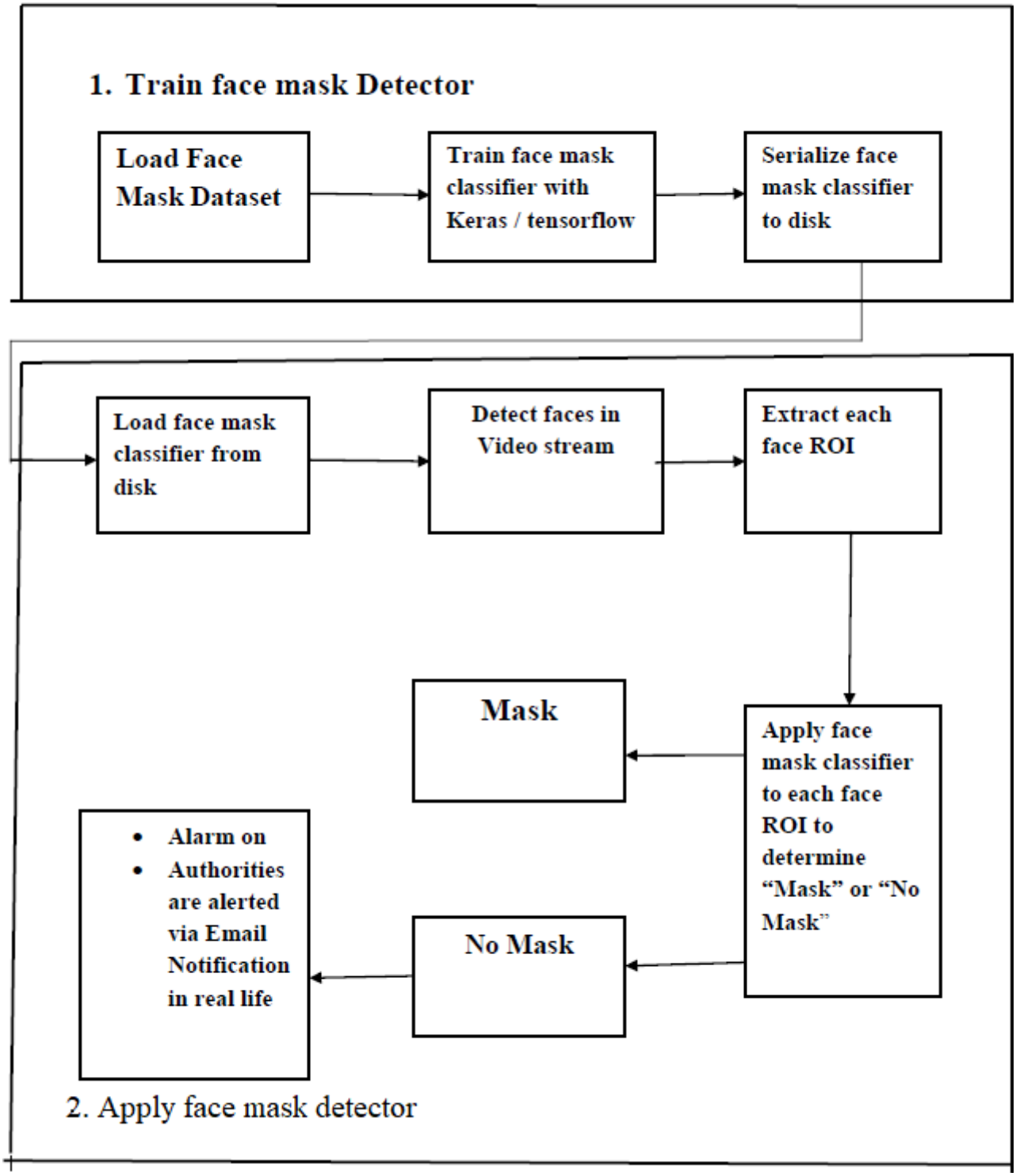
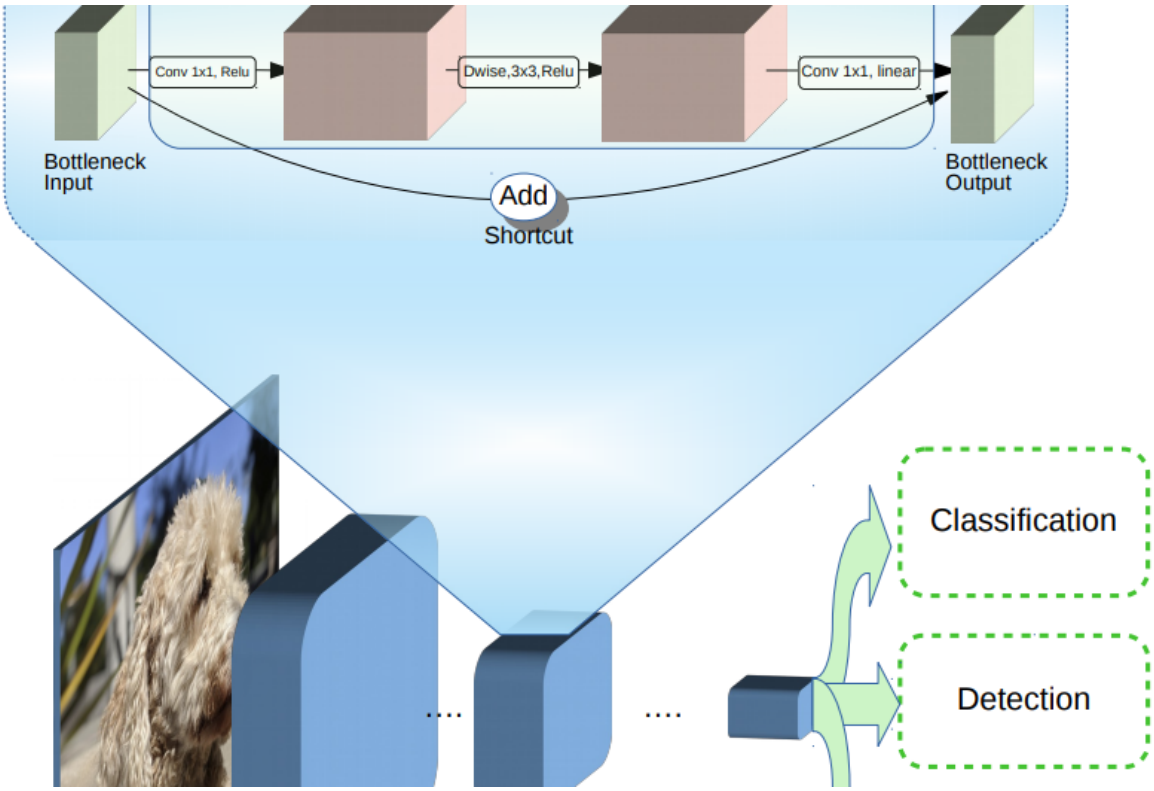


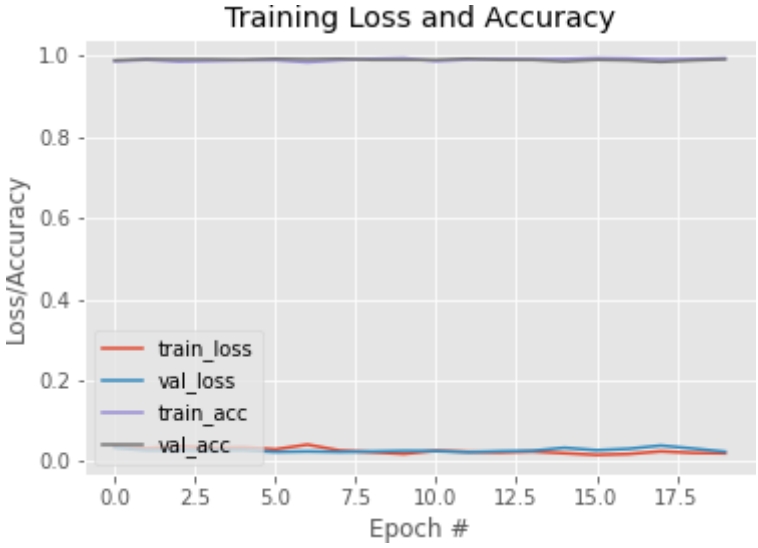

**Figure 3**

Decision flow chart of the proposed approach.




## Figure 4

MobileNetV2 Architecture.




## Figure 5

Epochs # versus Accuracy and Loss.

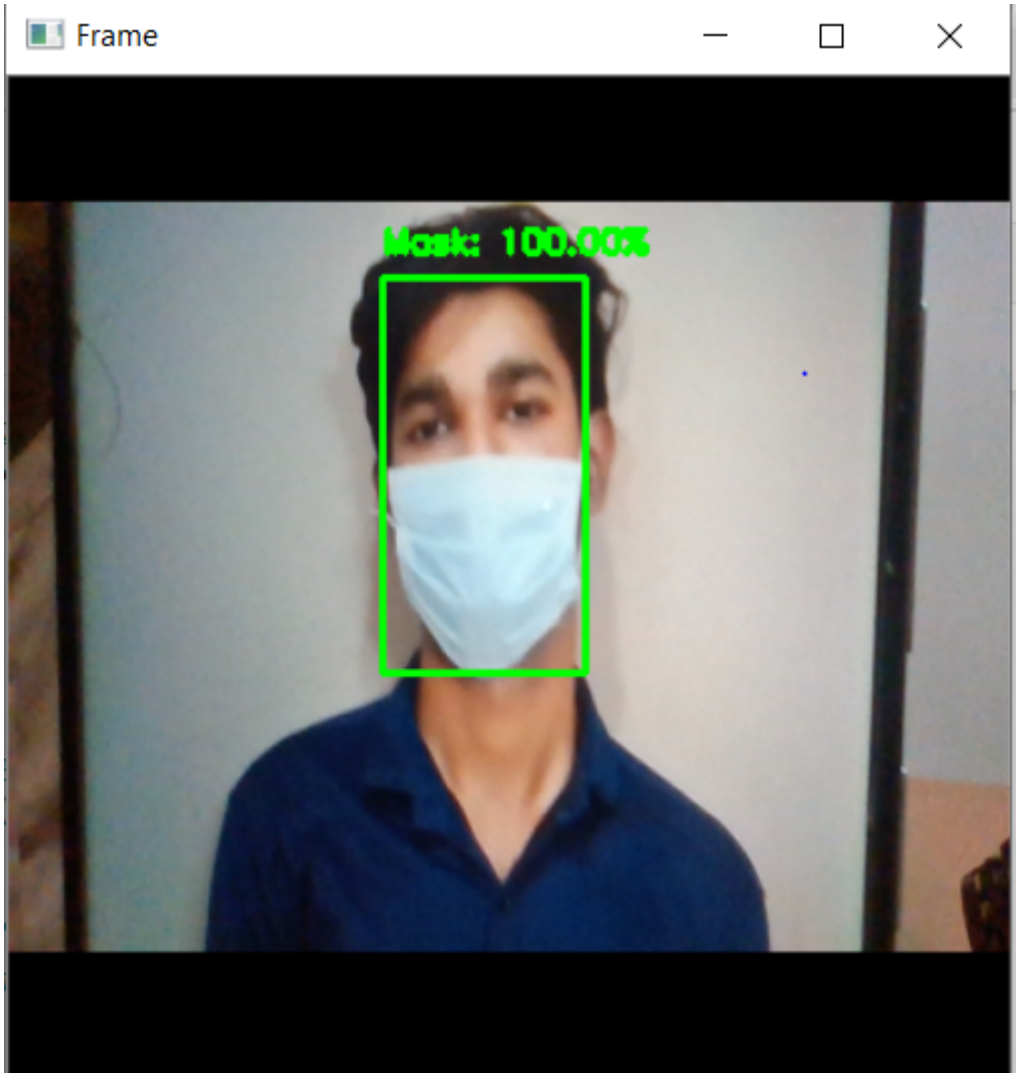



**Figure 6**

Analyzing the results of the live stream frame of one person with a probability of 100.00%, revealed that Mask was not worn.

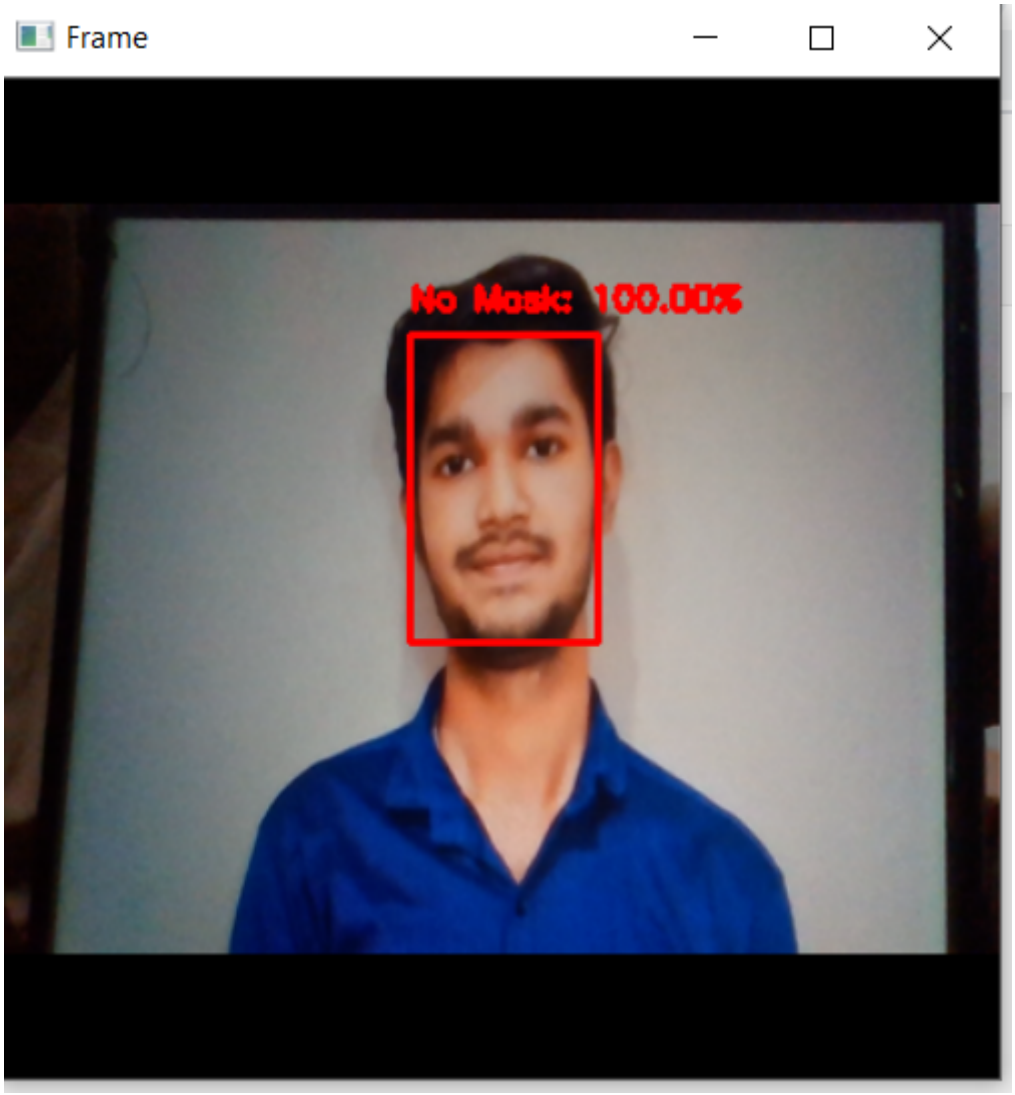



**Figure 7**

Analyzing the results of the live stream frame of one person with a probability of 100.00%, revealed that Mask was worn.

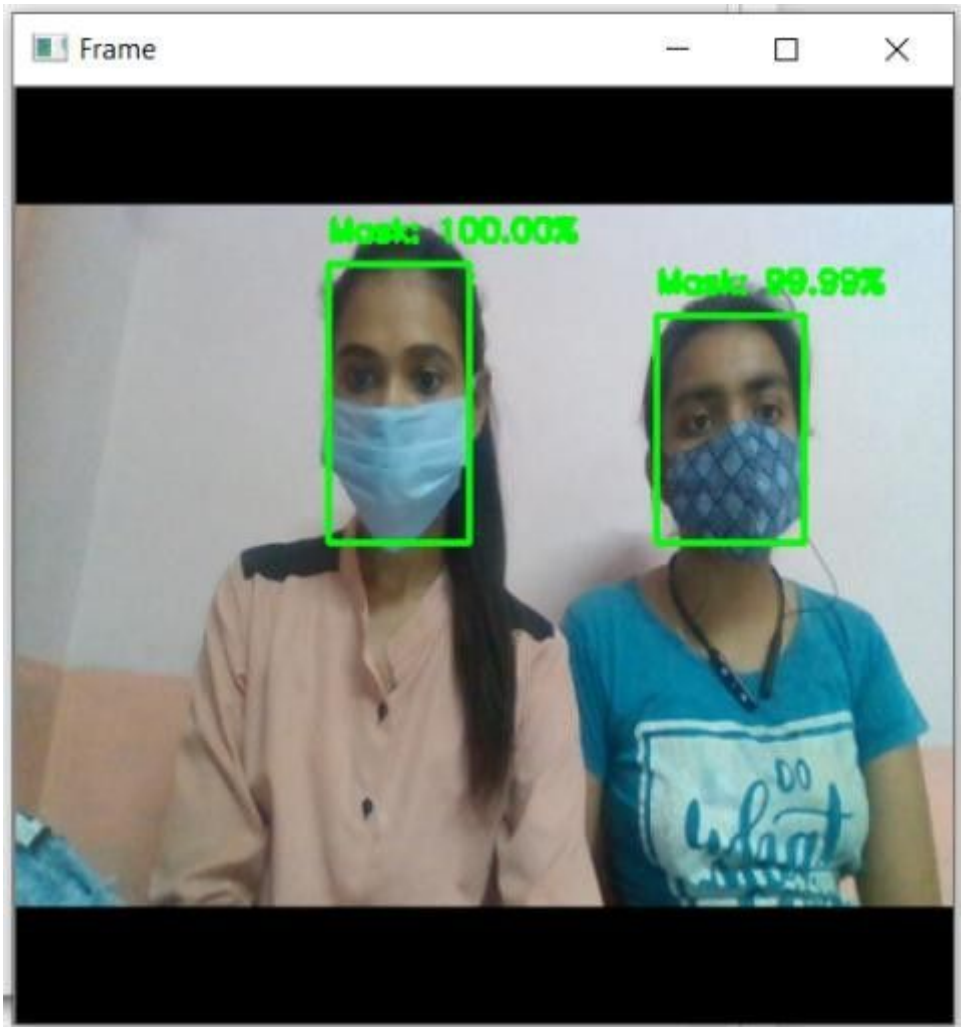



**Figure 8**

Analyzing the results of test photographs with a probability of 100.00% and 100.00%, respectively, revealed that Mask was worn.

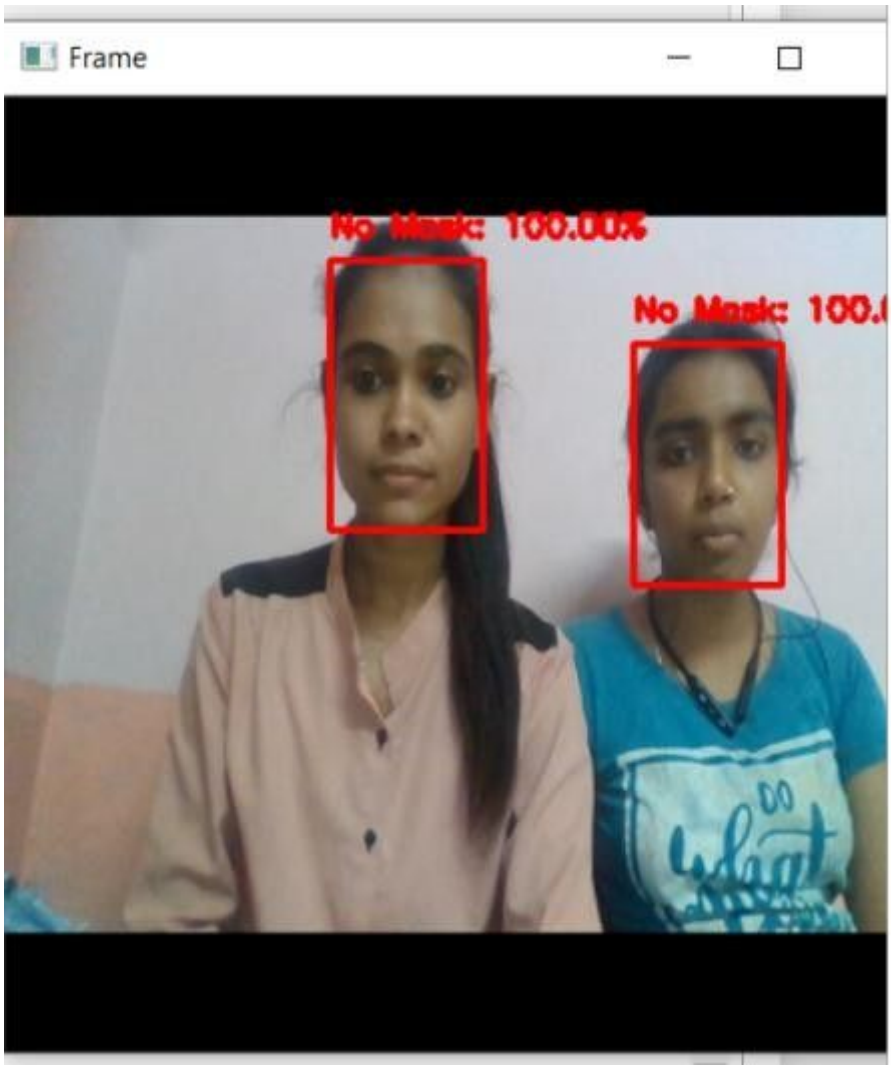



**Figure 9**

Analyzing the results of test photographs with a probability of 100.00% and 100.00%, respectively, revealed that Mask was not worn.

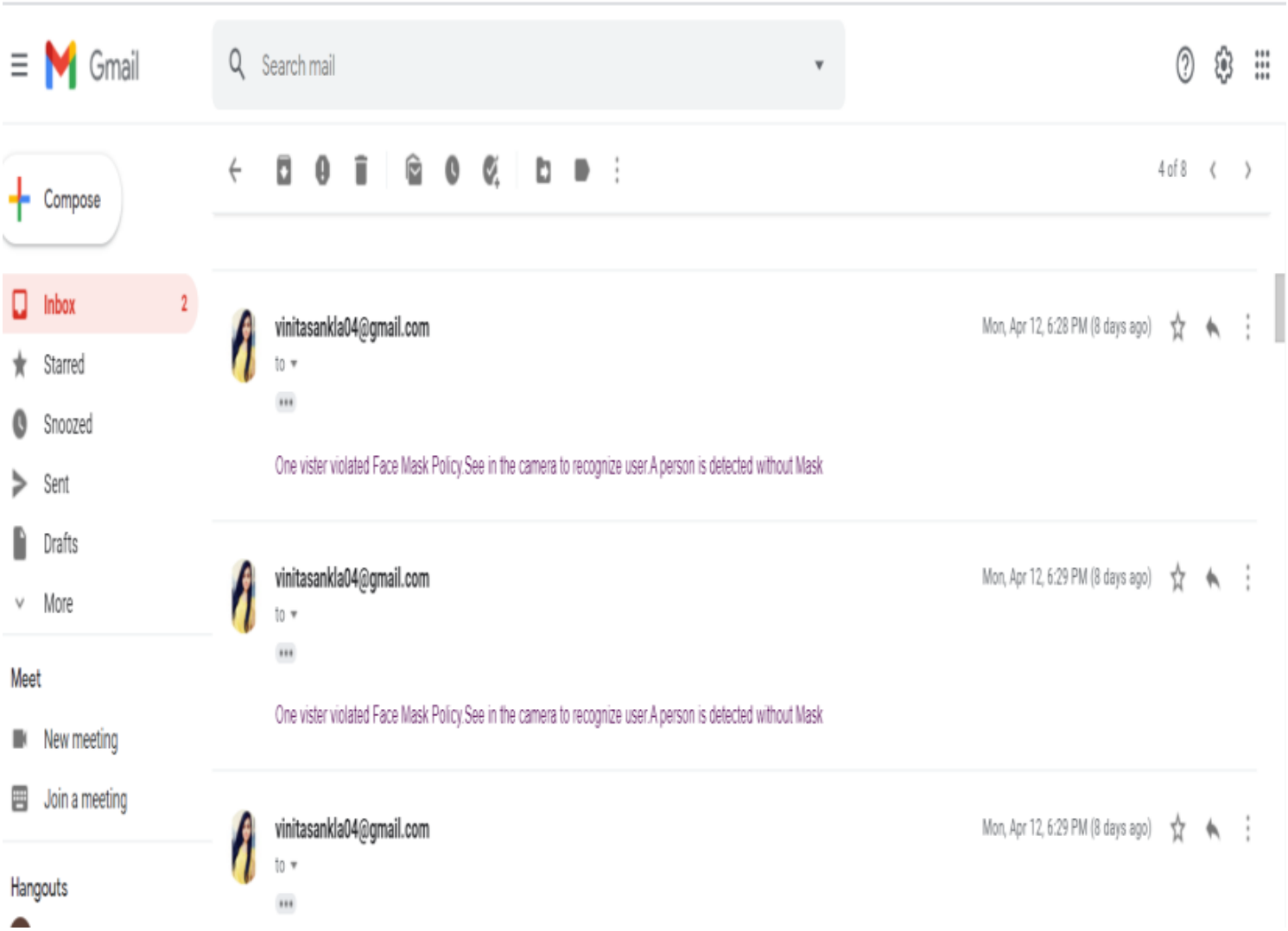



**Figure 10**

Snapshot of Email notification when person is not wearing face mask.