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Face Mask Detection using Deep Learning

Dr. Murali G [1], Professor, BTI

Ranjitha M [2], Rashmi D Happal [3], Sammed Jain D P [4], Yeshaswini V [5]

Department of Information Science &Engineering

SJB Institute of Technology

Abstract: The recent COVID-19 virus outbreak has caused a global health crisis. According to the World Health Organization (WHO), one of the effective protection measures is to wear a face mask in public areas. The COVID-19 pandemic enforced the governments across the world to impose lockdowns to prevent virus transmission. Reports indicate that wearing facemasks at workplace clearly reduces the risk of virus transmission. Therefore, we built a face mask detector with computer vision using Python, OpenCV, Tensor Flow and Keras. In our proposed system we use live video streaming. We train the system to detect the faces of the registered people at a particular workplace. The main aim here is to identify whether a person on the live video stream is wearing a face mask or not. If it detects a person who is not wearing a mask, then it sends an alert message stating the same. This method attains an accuracy of up to 95.77%. We use the mobile net model to detect the presence of masks correctly without causing over-fitting.

Keywords: Face mask; Covid-19; deep learning; Keras; OpenCV.

Introduction

The COVID-19 virus has spread throughout the world, resulting in widespread lockdowns. There have been more than 5 million infections of COVID-19 in 188 countries in the last six months. Due to the spread of the virus in crowded and overcrowded places, people are required to wear masks in public. In regard to workplace/college safety regulations, the World Health Organization recommends wearing a face mask in public areas as an effective method of preventing the transmission of viruses. In our country, police officers are responsible for checking whether people are wearing masks or not. As a result, there is a high risk of virus transmission while checking or investigating. An automatic face mask detection algorithm is presented that is based on deep learning and computer vision. The proposed model could be integrated with Surveillance cameras to disrupt the transmission of COVID-19, by detecting faces without masks. For this we have used in-depth learning and ancient machine learning strategies with OpenCV, Tensor and camera flow. We achieve high accuracy and spend less time on the training and acquisition process.

Literature survey

The research [1] combined both the correlation filters and CNN feature which are good at object tracking. To increase the success rate and accuracy of the object tracking algorithm they have used CNN feature which describe the appearance of the target. ResNet has been used in this paper due to its advantages of having high success rate, accuracy, and efficiency. ResNet includes the convolutional feature maps which are used to encode the target appearance. The result of this method is that it could track the target robustly more easily and also accurately even if there are cases of occlusion and scale variation.

In [2] researchers developed a model which mainly focuses on recognizing different masked faces with high accuracy rate. To obtain both the face detection and face alignment they have used MTCNN framework as a solution. Here there are three stages (P-Net), R-Net and O-Net. These networks are used to perform classification of face, regression of bounding box and facial landmarks. The experiment results indicate lower-false-positive rate and lower false-negative rate, respectively.

In [3] researchers developed a model which recognize masked faces which include occlusion. In this, statistical procedure is selected that is Principal Component Analysis (PCA). For face detection they used Viola Jones algorithm and ORL database is used to acquire large dataset. This model gives accuracy of 95% for non-masked images and accuracy rate of 75% for masked images. CA gives poor recognition rate for masked face images rather than non-masked faces.

In [4] the model facial mask detection is developed using Semantic Segmentation. Semantic segmentation of face is performed with help of CNN, and it also used to separate out the face by classifying each pixel of the image. This model requires RGB image of any arbitrary size. The basic VGG 16 architecture is used in this model. This network detects both non frontal and multiple faces from single image.

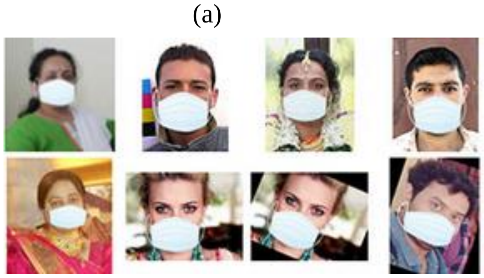
In [5] they have designed a CNN Network which helps in verification between occluded and non-occluded faces of same identity and shared information between both images into same CNN model. This paper talks about the approach performed with superiority to the state-of-the-art face verification technique

In this paper [6] the problem of mask attack is addressed along with face recognition to achieve authentication. Global and local features are used for recognition and authentication, respectively. This provides low HTER of 7.6% and accuracy of 94% and 93% using texture and depth map respectively for 150 real and 150 mask sample.

1) Data

For this Model we need large dataset for pre-processing, and we have obtained this dataset from Kaggle. Kaggle contains large open datasets which are mainly used for machine learning and data science. Since it is an open website, it is easier for students to use it for their projects. Here we have used datasets of people's faces with mask and without mask. An approximate of 3000-4000 images have been used for the purpose of training. Larger datasets help us train more efficiently. The masked datasets are further trained and annotated as masked and un-masked, respectively.

(a)



(b)

Figure 1: Sample images of the dataset.
(a) Without mask images
(b) With mask images

2) Pre-processing

Once we have the dataset, it is important to pre-process it. For this we have used keras. Keras contains many utilities and deep learning modules which help in processing the image datasets. We first load the two categories of datasets that is masked and non-masked into two different folders respectively. With this the machine is trained to differentiate between a masked and a non-masked face. In this process we have tried to train the model in a way where it is able to recognize a face covered or occluded due to different reasons as non-masked.

In the pre-processing the next step is segmentation. In segmentation the images are broken down or partitioned into pixels based on the algorithm chosen. With this it becomes easier to analyze the image. This helps us in training the model for classification. The next step is to detect the faces in images or live video. The main aim in this step is to detect the faces with the mask and faces without mask. This process gives out better result for bigger dataset used. The model will be trained more if there are more images. It becomes very difficult for the model to detect if there is no appropriate dataset or has a very less data.

The next step is to extract face images. In this step, the images are first captured and then the face is taken from the dataset. Each image captured is checked for the detecting confidence. If the detecting confidence is more than 50 percent, the face is extracted. This extracted face is new considered as a new image and all the extracted face images are stored in a new folder. After each extraction, the count will be incremented for the future reference.

After extracting the face images, the same step includes one more phase. This phase includes applying the face mask classification to each image. The images are classified to two groups. One with masked face and one with unmasked face. The result will be printed according to this classification.

The final step is the result. In this the console will print the output according to the classification. The dataset contains the images of all the employees or the students. The student's image or the employee image will be assigned with a unique id. The model not only detects the face with mask or face without mask in the live video, but also detects the individual with the respective name. And an alert message is generated if a person is not wearing the mask and this message is sent to the institution or office along with the name.

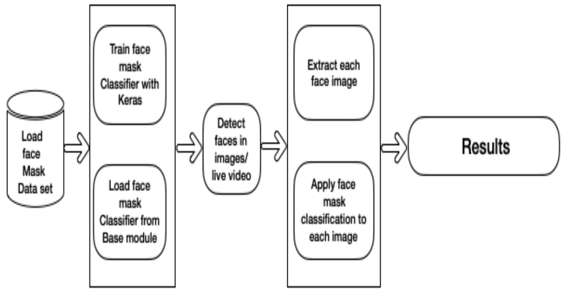


Figure 2: Architecture used

3) Obtaining images

In order for the system to recognize faces, we must initially capture the person's face and give a particular id. The system takes the specified number of images of the person and stores it under the given id. In our model we have initialized this value to 100. So, the system captures 100 images of the person. This can be interrupted by pressing the 'q' button. The capturing of images from the live video is done by using the videoCapture() method which is imported from the OpenCV(cv2) package. The captured images are converted to gray scale using the cv2.cvtColor () method. These images which are converted to gray scale are different sized images. These are cropped into fixed rectangular frame. The 'datasets' folder consists of these images. In this phase, the person who is training the face should do it with the base face i.e., without any occlusion of the face. It is important to change the id in the program content before we start with another new face. With this the datasets folder is successfully created.

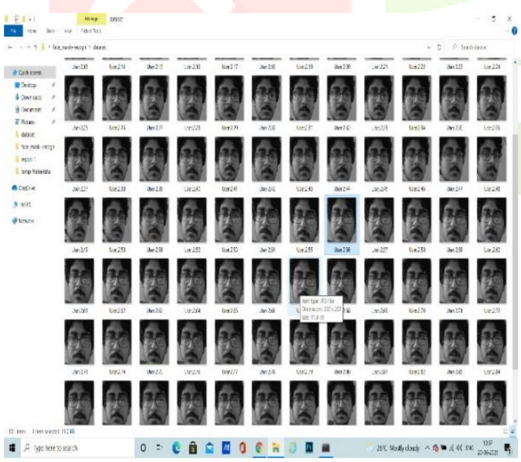


Figure 3: The datasets folder

4) Training

Once we have captured the images and stored is into the datasets folder, we need to train the model so that it understands and maps the faces with the respective ids. For this we use the local binary patterns histograms. The LBPHFaceRecognizer_create () method which is available in the OpenCV package is used to obtain the binary patterns of the images. The cascade_classifier takes the xml file haarcascade_frontalface_default.xml as the parameter. At this point the haar cascade algorithm is used. Now these images are converted into the numpy array. Once the faces from the training model are obtained, the multi-scaling is used. Each face from the folder is put into the face samples list. The ids list is then appended with the corresponding ids. These two arrays are further used for recognizer training. This model is finally saved to trainer.xml file.

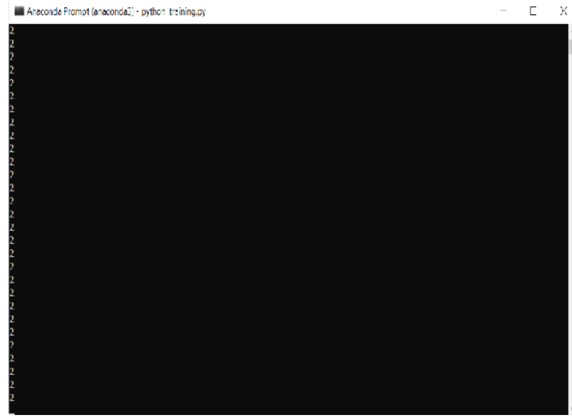


Figure 4: Training of the datasets

Figure 5: The yml file

5) Applying the face mask detector

After Training the model, the face mask detector is ready to use. The OpenCV Computer Vision for activating the camera. The faces are detected, and a rectangular bounding box is obtained along the circumference of the face. This rectangle is red in color f there is no presence of the mask and is green in color if there is a mask. Above the rectangular bounding box, the accuracy of the prediction can be seen. The messages "mask" and "no mask" are displayed continuously on the prompt. Using Twilio, we send an alert message to the authorized person if a person is not wearing the mask. The person’s name is trained along with their face during the training and hence the person's name is also sent to the authority if he/she is not wearing the mask.

6) Flowchart

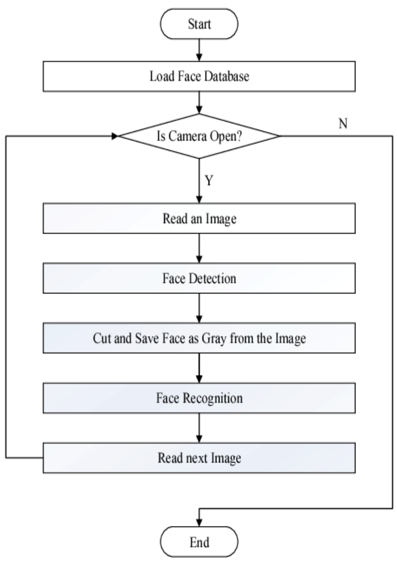


Figure 6: Flowchart of the proposed system

7) Tests performed

We have tested our model against various inputs. The model classifies the masked and un-masked faces with an accuracy of 95%. It is also able to map the faces with the correct ids with an accuracy of 97%.

8) Results

The face mask detector classifies the faces as masked and non-masked and also sends an alert message if the person is not wearing the mask. If the person's face is already trained, their name is sent in the alert message. This message is sent to the concerned authority.

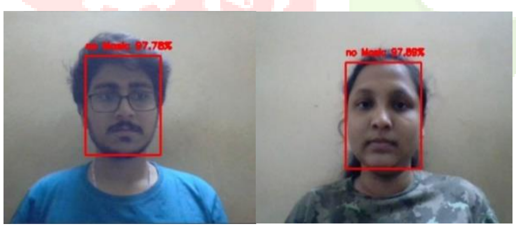


Figure 7: Detecting faces without mask

This figure displays the results of the face mask detection as no mask when a live stream of the face is captured. Face mask detector extracts each face ROI and then applies a face mask classifier to every ROI to determine whether a mask has been applied or not. This result shows the accuracy of the no mask, while the red rectangle box tells us the person is not wearing a mask.

Figure 8: Detecting faces with mask

The figure below shows how face mask detection looks in live video streams when the face is captured. After detecting face mask, comparing each ROI to a face mask classifier determines if the mask is present. Mask accuracy is displayed here, and green rectangles indicate that a mask is worn.

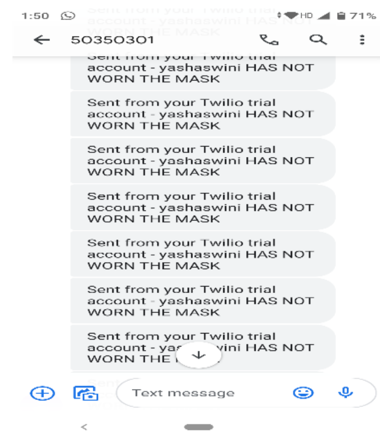


Figure 9: Alert Message

This figure illustrates the alert message sent when a face mask is not determined. When this occurs, the system sends an alert message to the registered number. The alert message includes the person's name and a statement saying "person is not wearing a mask".

CONCLUSION

The face mask detector detects whether a person is wearing a mask or not. It also gives the accuracy of its detection. In case a person covers his/her face with the hand, the system still detects it as no-mask. Only in our country this is done by the government officials or security guards manually. This increases the risk of virus transmission and is unsafe. With the use of the face mask detector the risk of virus transmission is reduced. It also saves time as it can detect multiple faces simultaneously. It is also useful in the aspect of sending an alert.

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