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Deep Learning based Face Mask Detection

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ABSTRACT

Severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) pandemic is still continuously spreading all over the world. With the advent of the omicron variant, the situation is still under speculation in many parts of the world. Different studies have shown that usage of masks is the most significant way to avoid spreading of the virus from one person to another through air. Hence, it becomes crucial for people in public areas to wear masks. In this paper, the model trained and tested helps to identify individuals who are wearing a mask properly or not.

This could be done in a public place which can be monitored using cameras such as Closed-Circuit Television (CCTV) cameras. The model works on image processing and deep learning technologies.

The model was trained on a real-world dataset and successfully tested using live video streaming. One can improve the model's accuracy by experimenting with different variables, many people at varying distances and hyper characteristics and the frame's position. This study is beneficial in combating the spread of the virus and avoiding contact with the virus. The proposed model's superior performance makes it ideal for video surveillance systems.

Keywords: Deep Learning, Computer Vision, OpenCV, Tensorflow, Keras.

1. Introduction

On a global scale, the COVID-19 corona virus pandemic has affected everyone. It stifled the entire nation's economic expansion around the world as well as the loss of life. Corona virus disease 2019 (COVID-19) is a new respiratory disease caused by the corona virus 2 of the severe acute respiratory syndrome, or SARS-CoV2. As of December 5, 2021, the novel corona virus disease (COVID-19) has already affected over 6.9 million people, claiming more than 400 000 lives in over 200 nations all over the world. COVID- 19 had infected almost five million people in 188 countries in less than six months. The virus spreads due to the transfer of tiny droplets through close contact, especially in congested and overcrowded places. This pandemic has resulted in several shutdowns of various industries. Furthermore, due to their major impact on people's daily lives, several sectors such as maintenance projects and infrastructure building have not been discontinued yet. There have been studies that show that wearing a facemask is crucial in preventing the virus from spreading. According to research, N95 and surgical masks are 91% and 68 percent efficient at preventing virus transmission, respectively. Wearing these masks successfully disrupts airborne viruses, preventing them from reaching a human's respiratory system, and it is a cost- effective strategy to reduce mortality and respiratory infection problems.

Due to insufficient facemask use, the efficacy of facemasks in reducing disease transmission in the general public has been reduced. It is critical to build an autonomous facemask detection system that would provide individual protection while also preventing a local outbreak. So, It has become essential to develop an automatic detection for wearing facemask. Deep learning technique combined with computer vision enables us to develop model for this task. Convolutional Neural Network is used in this model. It's a deep neural network model for visual imagery analysis. It accepts picture data as input, collects every data, and sends it to the layers of neurons. It contains a fully linked layer that processes the final output, which is the part of image prediction. Using OpenCV, Tensor Flow, and Keras, the model combines deep learning and the traditional machine learning techniques. During the training and detection process, we will obtain the best accuracy while using the least amount of time.

The model is also tested with other hyper parameters. The two parameters that were tested were learning rate and step size. Learning rate is a tuning parameter that is used in optimization models to determine the step size of the model and to assist lower the loss function. It's a crucial hyper parameter because it determines whether the model converges or overshoots. Batch size, epochs, and other hyper parameters are also used. The model made advantage of OpenCV to achieve its goal of capturing frames from a video stream.

2. Related Work

Deep learning is a significant advancement in the science of artificial intelligence. It has recently demonstrated significant potential in image analysis for retrieving small characteristics. The challenges that a computer vision (CV) approach must cope with include pattern learning and object recognition. Image categorization and object detection are both included in object recognition. Using surveillance equipment and an effective object recognition algorithm, the task of recognizing the mask over the face in the pubic region can be accomplished. The object identification process begins by generating region recommendations, which are then classified into related classes.

Convolutional networks are almost certainly used in classification tasks as well. The convolutional layer is packed or contained in standard topologies like AlexNet and VGGNet. AlexNet, the ImageNet LSVRC-2012 competition winner, has five convolution layers and three fully linked layers, whereas VGGNet, an upgrade on AlexNet, gradually distributes huge kernels with numerous 3x3 kernels. New architectures, like as ResNet use an accelerated link on training accuracy, allowing for considerably deeper networks while avoiding overload processing. For original feature extraction, these structures are frequently used in picture recognition frameworks. The architectural features of VGG-16 as the foundation network for face recognition and the Fully-Convolutional segmentation network are used in our suggested study. The VGG-16 network is fairly resilient in terms of extracting features and is computationally less expensive. Nonetheless, most segmentation topologies, Fully Convolutional Networks rely on input image downsampling and upsampling in that order.

Deep Learning is made up of a huge number of neural networks that use a computer's numerous cores and video processing cards to govern the neural network's neuron, which is classified as a single node. Because of its popularity, deep learning is employed in a variety of applications, particularly in medicine and agriculture. Its applications include disease identification, detection, and recognition in humans, animals, and plants fruit image detection and grading and picture capturing robots such as facial recognition via an attendance system.

As for the convolution process seen in fig. 3, it starts with the retrieved input picture and its features being processed through a 3x3 filter with a stride of 1 as described in the convolution procedure (Conv). Through the dot product of the previous and the output of the Conv procedure, a featured map is produced.

2.1 Dataset Used

We produced an artificial dataset by applying facial landmarks to standard photos of faces. Facial landmarks help you to find out where a person's eyes, brows, nose, mouth, and jaw line are. This created a dataset in an unnatural method by using a mask on a non-masked person photograph. Those photos, however, were not utilized in the artificial generation process again. When non-face mask samples were included, there was a risk that the model might become substantially biased. Using such dataset photographs from multiple other sources was a risk. As a result, they included a dataset that consisted of masked and unmasked photographs of humans to compensate for the error correction(Fig 2).

3. Methodology

The model proposed here is designed and modeled using python libraries namely Tensorflow, Keras and OpenCV. CNN identifies and categorizes images based on previously learned properties. When getting and assessing the necessary features of graphical images in a multi-layered structure, it is particularly effective. Figures 1 through 3 depict the outline of the proposed approach for identifying facemasks. It describes the proposed system, which is entirely made up of picture acquisitions as illustrated in fig. 1. In fig. 2, a person wearing a facemask and not wearing a facemask, as well as a CNN architecture categorization, are used to collect data
For this we collected a database of images which consist of about 1376 images with 690 images containing people wearing face masks and 686 containing people without masks. By developing the model and using these images we can predict whether a person is wearing a mask or not using a web-cam.

Fig.1: Example of pics with mask used to train the model

Fig.2: Example of Data Set

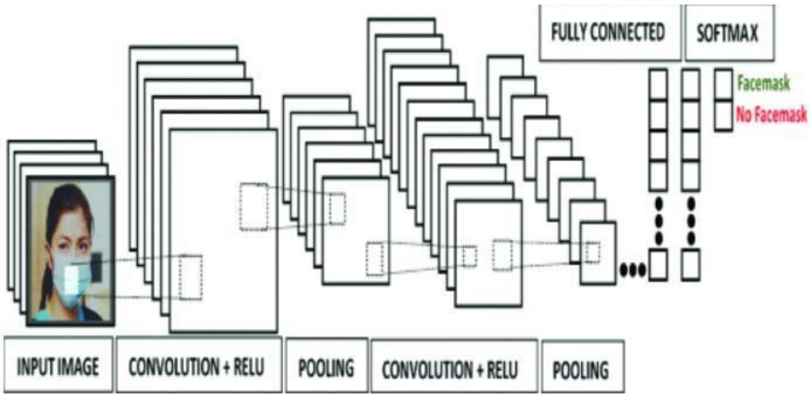

Fig.3: CNN MODEL LAYERS

Proposed Architecture for the model

1: Dataset was augmented to include more images for our training. In this step of data augmentation, we rotated and flipped each of the images in our dataset.

2: Visualization of total images in the data set was done.

3: We splitted our data into the training set which contained the images on which the CNN model was trained and the test set with the images on which our model was tested. And then we build our Sequential model with various layers such as Conv2D, MaxPooling2D, Flatten, Dropout and Dense.

4: We fit images in the training set using Keras library.

5: We used the Haar Feature-based Cascade Classifiers for detecting the features of the face. This cascade classifier is designed by OpenCV to detect the frontal face by training thousands of images.

6: In the last step, we used the Open CV library to run an infinite loop to use our web camera in which we detect the face using the Cascade Classifier. The resulting model predicted the possibility of each of the two classes ([without mask, and with mask]). Based on which probability will be higher, the label was chosen and displayed around faces.

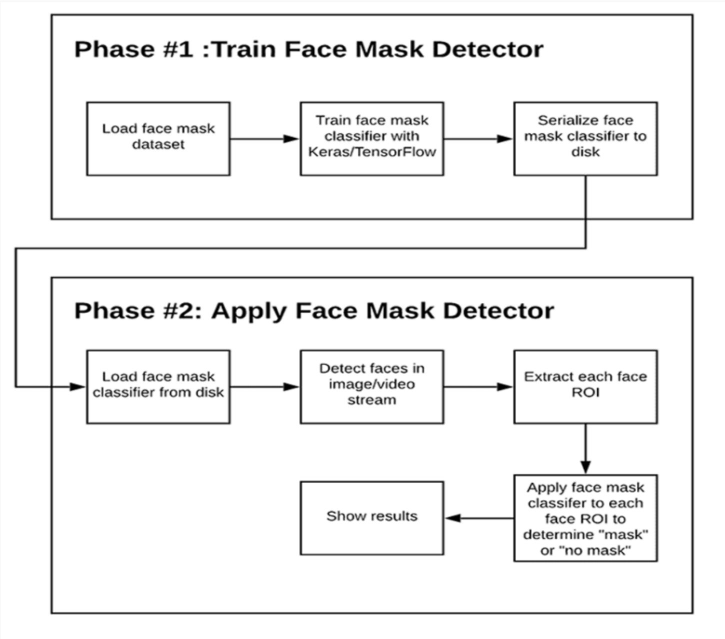

Fig. 4:Proposed Architecture for the CNN Model

4. Results

We see that after the 50th epoch, our model has an accuracy of 98.86% with the training set and an accuracy of 96.19% with the test set. This implies that it is well trained without any over-fitting.

This research manuscript provided a study on real-time facemask recognition with an alarm system using Convolutional Neural Networks and deep learning approaches. Facemask detection is made more exact and faster using this method. The test findings demonstrate a high level of accuracy in detecting people who are wearing or are not wearing a facemask. The trained model was able to complete its task using the CNN model, obtaining a performance accuracy of 98 percent.

The various metrics used to evaluate the model are accuracy, precision, recall .

Accuracy = Tp + Tn / Tp + Tn +Fp + Fn

In the above, Tp represents: True positive, Tn: True negative, Fp: False positive, and Fn: False negative

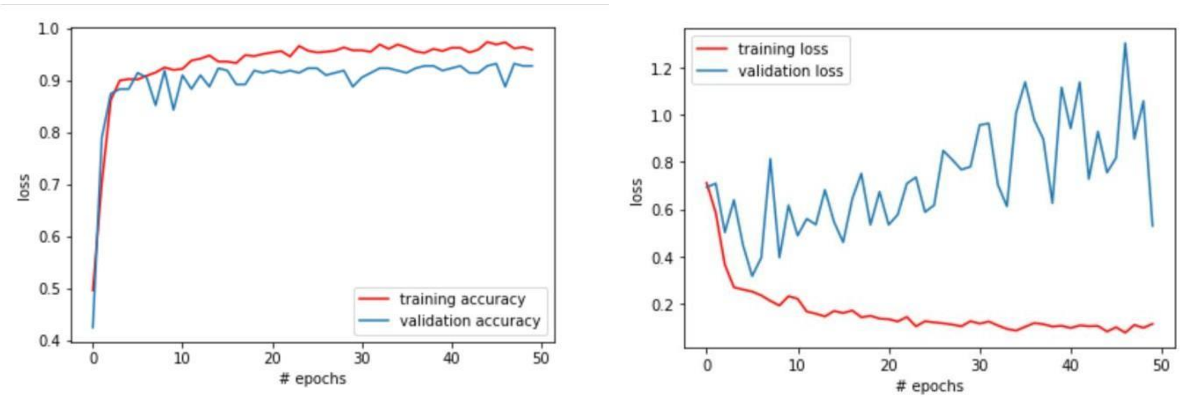

Fig 5: Number of epochs vs loss or accuracy

5. Conclusion

Measures should be taken to slow the spread of the COVID-19 pandemic. In neural organizations, we demonstrated a facemask detector using Convolutional Neural Networks and motion learning algorithms.

In this work, a deep learning-based approach for detecting masks over faces in public places to curtail the community spread of Corona virus is presented. The proposed technique efficiently handles occlusions in dense situations by making use of an ensemble of single and two-stage detectors at the pre-processing level. Firstly, the proposed technique can be integrated into any high-resolution video surveillance devices and not limited to mask detection only. Secondly, the model can be extended to detect facial landmarks with a facemask for biometric purposes. After building the model we label two probabilities of results 0 as without mask and 1 as with mask. If a person is wearing a mask then it will show a green color box and if not then it will show a red box.

6. Future work

Future development will involve the integration of physical distancing, in which the camera identifies whether or not a person is wearing a facemask while also measuring the distance between each individual and sounding an alarm if the physical separation is not followed properly. To improve performance in detecting and recognizing people wearing facemasks, it is advised combining many CNN models and comparing each model with the highest performance accuracy during training. An alternative optimizer, increased parameter settings, fine-tuning, and the use of adaptive transfer learning models are also recommended by the researchers.

Further, we will work to improve the accuracy of multiple face mask detection by adding datasets with images of people wearing masks that do not cover their noses properly since it does not show a great accuracy to identify people who do not wear their masks properly by covering their mouth and nose completely. As well as detecting the masked face using the Face Net model of Convolutional Neural Network will further help in increasing the accuracy of the model.

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