COVID-19: Detection Of Face Mask Using Tools Like Opencv, Keras/Tensorflow And Deep Learning

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Abstract- *The COVID-19 pandemic is an unparalleled crisis which has led to a huge number of casualties and has led to security problems. To curb the spread of this virus, people are suggested to wear masks which will protect them. But, these masks make face recognition difficult. This can create problems in tasks where face recognition is required. The primary focus of researchers in this situation is to come up with new and efficient ways to handle such difficulties. This paper highlights the use of different techniques to determine whether a person has worn a mask. The proposed system treats images as a collection of possibly overlapping patches. To make the position of a face consistent, face alignment can be used as a technique to reduce variations that might occur due to external factors like external lighting, background, how the person poses, etc. We have also used deep learning techniques which help in distinguishing faces recognized. This study can prove beneficial to control the spread of the virus. This paper highlights the use of the methods of computer vision and deep learning using Python language and libraries like OpenCV and TensorFlow/Keras.*

Keywords- COVID-19, masks, face recognition, people, face alignment, computer vision, deep learning, Python, OpenCV, TensorFlow, Keras.

I. INTRODUCTION

On a global scale, the COVID-19 pandemic has affected everyone and has curbed the economic growth of the whole world. To curb the spread of this virus, the World Health Organization (WHO) has urged countries to enforce protocols like wearing a mask, observing of strict social distancing in places where public gathering is possible and disinfection of hands with the help of sanitizer on regular intervals. As the population of the world is increasing, the number of people affected by the virus has also increased. As of 23 April 2021, in India, around 16.3 million people have been affected by the virus of which 187 thousand people have lost their lives due to the virus. The spread of the virus has brought the whole world to a standstill.

In recent years, the application of face recognition has developed rapidly in the world as a system for computer security and especially today, it has received more and more attention. This technology has many typical applications in fields like public safety, civil economy and home entertainment. This technology can be used for attendance of employees in a company which can help in recording real-time attendance of the employees. This method has proved to be more accurate than fingerprint attendance which has a 5% chance of encountering an error. Although there has been extensive research in this field, there are still some difficulties like matching images across different types like thermal, near-infrared (NIR), 2D, 3D and likewise.

Future work in face mask recognition can lead to creation of an algorithm that offers a higher speed and accuracy.

The disease coronavirus (COVID-19) is an infection which cannot be resisted easily. People with problems **like** cardiovascular infection, diabetes and ongoing respiratory problems are more likely to get infected by this virus. Protecting yourself and other people from getting infected by this virus can be done by washing hands by a sanitizer or a liquor-based rub, wearing masks and avoiding contact with surfaces as much as possible. The above things can be implemented by us by ourselves. Through this study, we try to urge people to wear a face mask as it is essential for their as well as others safety.

Studying artificial intelligence is like studying maths or science. Since the past decade, AI has given mankind many things like viable web search, driverless vehicles and many more things. But face recognition has been affected significantly by variation in pose, illumination of the face of the person and expression on the face of the person which can be observed in many real world images.

II. LITERATURE SURVEY

The suggested schemes and the experimental authentications can be seen by the results obtained. It is used in companies as a completely legal corporation and wireless software design.[1] The Modular Histogram of Oriented Directional Features (MHODF) helps in aligned local description which helps to encrypt various patterns of images of people's faces under different lighting.[2] In this paper, the performance of the detector was evaluated by applying the face detector model on the face recognition databases available. We found out that the comparisons that were made with up to the minute databases which were based on unfair settings.[3] Adaptive Pose Alignment (APA) can help greatly to reduce difference within a class and correct the noise (unwanted changes) made by the usual method of the process of positioning. They learn the positioning templates adaptively according to facial poses. They propose a more simple, yet effective feature of normalization which is a method that generates more preferential feature representation of a face or a set of faces.[4] This study uses deep learning techniques to recognize whether a person is wearing a mask on the face or not. The dataset used contains as many as 25,000 images using a pixel resolution of 224x224 pixels. The system develops the Raspberry Pi-based real-time facemask identification. [5] Spoofing is the act of simulating a valid user by creating a counterfeit of data to gain an unlawful access. This paper highlights the inspection of potential of duplication of subject-specific 3D facial masks for different recognition systems. They address the detection of problem of the more complex attack type that can occur. [6] The proposed face mask detection platform uses an artificial network which helps in identification of a person with and without a mask. MobileNet_V2, which is a type of neural network, is used as algorithm for classification. [7] This paper focuses on masked face detection and identification using a single camera. The dataset employed consists of real-world video examples comprising seven individuals with various orientations, illuminations and obstruction. Experimental results show that RetinaFace and VGGFace2 achieve up to the minute results of 92.7% on overall performance and 94.5% on accuracy of face verification. [8] Proposed framework capitalizes on the MTCNN (Multi-task Cascaded Convolutional Neural Networks) face detection model which helps to identify the faces and facial landmarks corresponding to those faces present in the video frame. The model was tested on a dataset which consists of a collection of videos in which the movement of people in public spaces was captured. [9] The proposed model employs a global pooling layer for performing the flattening of the feature vector. A fully connected dense layer associated with the softmax layer has been utilized for classification. [10]

III. METHODOLOGY

A. Object Detection:

The tasks of object detection can be understood by;

1. <u>Classification</u>:- To categorize given images into certain groups of information, where each group has a predefined category or ID which helps in the description of the image.
2. <u>Detection</u>:- When compared to classification, detection is concerned with understanding the background and foreground of the image. The output obtained here is a list, where each item of the list uses a data group which gives the category and position of the detected list item.
3. <u>Segmentation</u>:- Here we get a pixel-to-pixel description of the image which helps to give meaning to each pixel category. It is suitable for complex images.

B. Experimental setup:

In this project, we have created a dataset of photos of two categories; one category has photos of people wearing a face mask and the other category has photos of people wearing no face mask. This dataset will be used to build a face mask detection model with computer vision and deep learning using Python, OpenCV and TensorFlow/Keras.

- Computer vision:- Computer vision is a field which deals with acquisition of high-level understanding by computers through digital images and videos.
- Deep Learning:- Deep Learning is one of the many classes of machine learning algorithms which makes use of multiple layers of the image to extract more high-level information from the image provided.
- Python:- Python is a general-purpose high level programming language. The design emphasizes on the philosophy of readability of the code with the notable use of significant indentation.
- OpenCV:- OpenCV (Open Source Computer Vision Library) is a library which consists of programming functions and it was developed by Intel in the year 1999, which is aimed at real-time computer vision.
- TensorFlow:- TensorFlow is a free open-source software library, developed by Google Brain team(First for their internal use but later released under Apache License 2.0) in 2015, for machine learning.
- Keras:- Keras is an open-source library software which provides a Python interface to the artificial-neural networks. It acts as an effective interface for the TensorFlow library. It's initial release was in 2015 but it's stable and bug-free version was released in 2020.

The first step is to create a dataset which will be a reference to the computer for identification of images with and without mask. This dataset will consist of two groups of images of people. One group will consist of people's images in which they have not worn any face mask. These images will mostly be portrait images with their face as the main component of the image. The other group of images will consist of images of the same people with masks. All images are portrait images. The next step will be applying the process of face detection. Here, deep learning method is used to perform face detection using the OpenCV library. The next step is to extract face ROI (Region Of Interest) using two libraries, namely OpenCV and NumPy slicing.

NumPy:- NumPy stands for 'Numerical Python'which is a library consisting of a multidimensional array of objects and a collection of array processing routines. It was created by Travis Oliphant in 2005.

NumPy slicing is used to split the input image. It treats the image as an array of elements and slices the image in the same way as we separate the elements in an array.

Then we detect the facial landmarks using dlib which will help us to know where the mask is usually placed on the face. Then we will place a mask artificially on the image captured by the camera and compare to the original captured image. If both images match, then the person is wearing a mask and if doesn't, then the person is not wearing a mask on the face. If the person is wearing the mask, a square, which identifies the region of the face in the image, will be green. If the mask is not worn, the square will be red and the square will be red until the person wears a mask.

C.Architectural Diagram: [11]

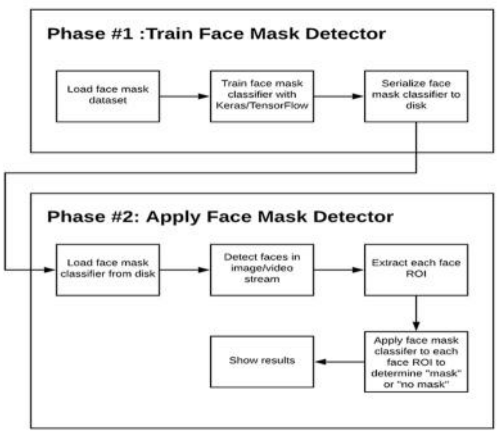

Figure 2.1: Architectural Diagram of face mask detector

In order to train a detector which identifies face mask, we need to break the training process in two distinct phases which may have sub-steps, as shown in above figure 2.1.

1. Training:-In this phase, the focus will be on loading the dataset of the face mask detector, training a model(using Keras/TensorFlow) based on this dataset and then serializing the model for the detector.
2. Deployment:-Once the training of the detector is completed, we can move on to the actual face mask detector which will perform the face detection and distinguish the detected face as a face with mask or a face without mask.

The dataset used has 1,738 portrait images of which

With face mask- 691 images

Without face mask- 687 images

Figure 2.2: Construction of dataset of images of people "with face mask" and "without face mask"

The dataset used in this project was created by,

1. Taking normal portrait images of people
2. Creating a *self-made computer vision Python script* to add face masks to the images, thereby creating an *artificial* (but still real-world applicable) dataset.

This process can be made a lot easier by taking the help of facial landmarks.

Facial landmarks help us to identify different facial structures, including:

1. Eyes
2. Eyebrows
3. Nose
4. Mouth

5. Jawline

D.Implementation: [11]

To use facial landmarks in the construction of the dataset of people wearing masks on their face, we need to first start with an image of a person not wearing a mask.

Figure 2.3: Image of a person not wearing a face mask

Figure 2.4: Computing the region of face in the image

Now, face detection is applied to locate the face of the person in the image.

Figure 2.5: Extraction of Region Of Interest (ROI)

Once this is detected, the detector extracts the Region Of Interest (ROI).

From here, we apply facial landmarks which help to locate eyes, nose, mouth, etc.

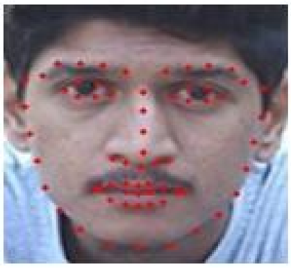

Figure 2.6: Detection of facial landmarks

Next, an image of a face mask is required which has a plain background.

Figure 2.7: Image of a face mask

This face mask will be applied to the face *automatically* in the image using facial landmarks (the points along the chin and the nose) which will compute the location of the mask.

Then, by making changes in size and orientation of the mask, it is placed on the face of the person's image.

Figure 2.8: Placement of the mask on the face of the person.

By repeating this process for all the images in the dataset, we can create an artificial face mask dataset.

However, there is an important thing which is to be remembered while creating this artificial face mask dataset.

If a specific set of images of people without masks is used in creation of the artificial dataset, then that set cannot be reused in the training dataset. For creation of a new dataset, we need to gather new images of people not wearing a mask and then we will be able to create a new dataset of people wearing a mask. Also, we cannot include the original images which were used to produce non-face mask samples as it will lead to a heavy biasing of the detector and failure of the detector to generalize the difference between image of person wearing a face mask and image of a person not wearing a face mask.

IV. RESULT DISCUSSION

After the creation of the artificial dataset and training the detector, we implemented the detector and got the result as shown in the figures.

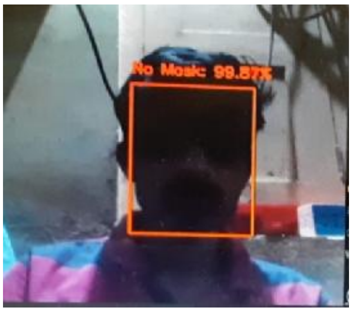

Figure 3.1: Implementation of the face mask detector (without face mask)

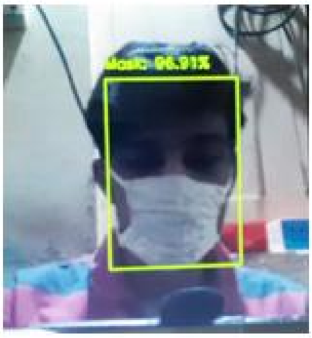

Figure 3.2: Implementation of face mask detector (with face mask)

First, we implemented the face detection program without wearing the mask. As shown in the figure 3.1, the detector identified the region of the face in the image correctly and marked the boundaries of the region by red color indicating that the person in the image is not wearing a face mask with an accuracy of 99.87%.

Then, we implemented the face mask detector again, this time by wearing a face mask. As shown in the figure 3.2, the detector identified the region of the face in the image correctly and marked the boundaries of the region by green color indicating that the person in the image is wearing a face mask with an accuracy of 96.91%.

V. BENEFITS

The benefits of face mask detector are:

- Manual Monitoring is very difficult for medical officers to check whether people are wearing face masks or not. So, we are making the use of webcam to detect the face of a person and try to prevent the virus from transmitting.
- This method is fast and has high accuracy.
- This system can be implemented in many places like ATMs, banks, etc.
- Using this technique, we can maintain the safety of people.

VI. LIMITATIONS

The system developed faces many difficulties in classifying faces covered by hand because it almost looks as if the person in front of the camera has worn a face mask. Also, the system is not able to determine whether a person is not wearing a face mask if that person is travelling on any vehicle. It also faces difficulties in detecting faces distinctly in a very crowded place and for such a structure, identifying people without face masks would be very difficult for this system. For best results from this system, there is a requirement of a high number of CCTV cameras to monitor a big area of population (for example, a complete city) as well as manpower which will enforce the rules properly on the people violating the rules.

VII. CONCLUSION AND FUTURE SCOPE

By the development of the face mask detector, we can detect whether the person in front of the camera wears a face mask or not. Though the accuracy of the model is 96-97%, it can be optimized and this optimization is a continuous process which helps us to achieve higher accuracy. This higher accuracy can be achieved by creating the mobile version of this face mask detector.

This system can be used in following fields:

- *Government:* To curb the spread of this deadly virus, the police could use the face mask detector using the surveillance cameras which are at traffic signals, alleys, markets, etc. to enforce the wearing of the masks in public places as well as places where there is a possibility of public gathering.

- *Office & Working Spaces:* The face mask detector can be used in the office premises to check whether the employees are maintaining the safety regulations while they are at work. The manager or the head of the office can monitor the employees without a face mask and can send those employees a reminder of wearing a face mask as a compulsory thing.
- *Hospitals:* With the help of the face mask detector system, hospitals can monitor the patients which are quarantined in the hospital and check whether they are wearing a face mask or not. The same can be implemented on the staff on duty too.
- *Airports:* This system could be used at international as well as domestic airports to detect travellers who are not wearing a face mask. The Faces of such travellers can be captured in the system at the entrance of the airport terminal. If a traveller has not worn a face mask, their picture is captured and sent to the airport authorities so that the authorities can take the required action.

In future we may enhance our scope by making it more responsive and effective by overcoming its limitations. We can also introduce a new system that can also identify the name or any related information of the person who has not worn the face mask.

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