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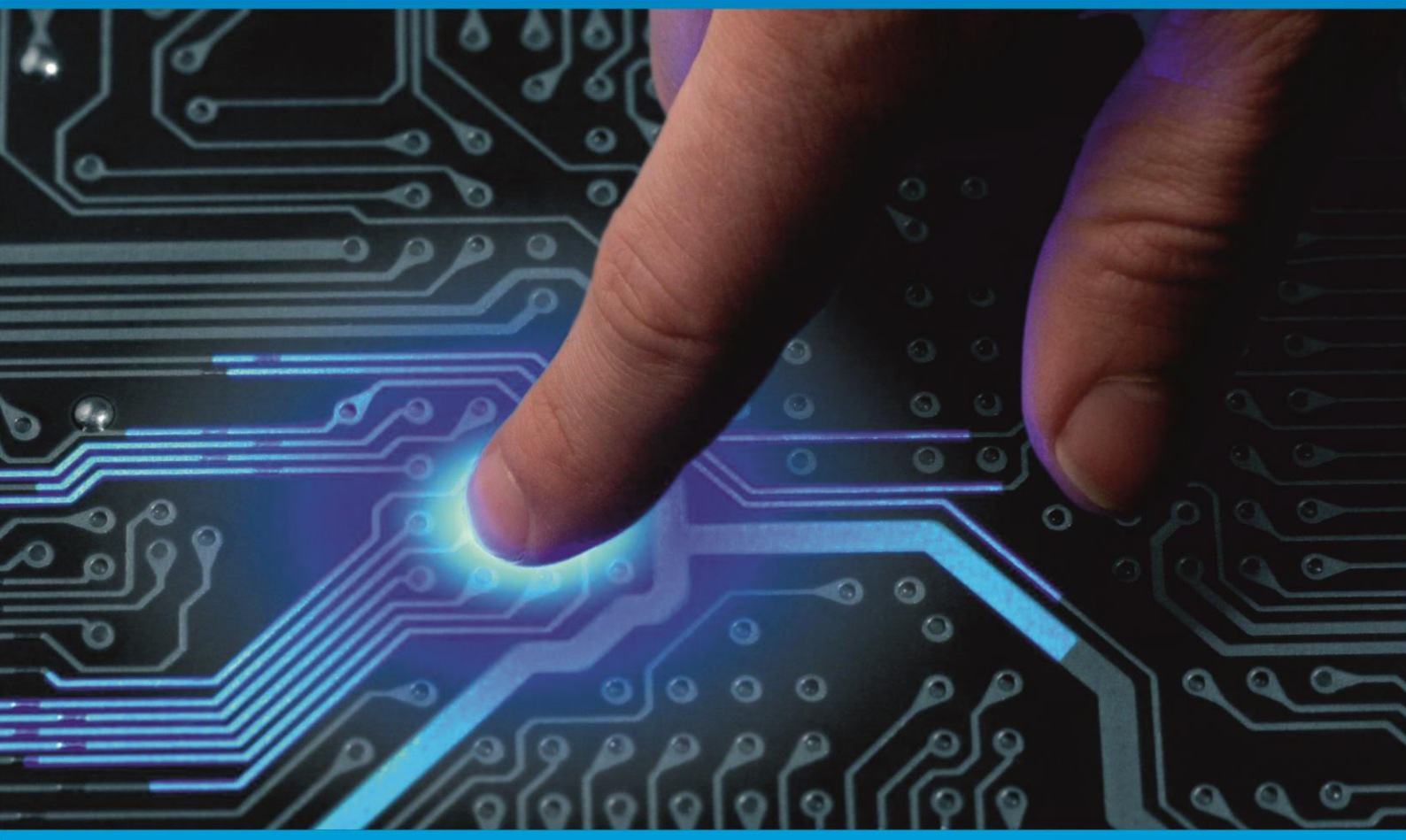

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Face Mask Detection System Using OpenCV, Keras/Tensor Flow and Deep Learning

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ABSTRACT: The COVID-19 pandemic caused by novel coronavirus is considered to be the most significant global health calamity of the century and the greatest challenge that humankind has faced since the 2nd World War. It has spread across the world, posing many health, economic, environmental, and social challenges to the entire human population. Also, the coronavirus outbreak has led to a dramatic loss of human life worldwide. Many precautionary measures have been suggested by the World Health Organization (WHO) like wearing a facemask in a public setting and often washing handsand maintaining social distancing to avoid being exposed to the virus. But at times, people aren't obeying these rules, which is speeding the spread of this virus. For such cases, the system proposed in this paper will detect people with and without a facial mask by using a webcam, and it will also alert the people who aren't wearing a mask by ringing an alarm. This face mask detection system is developed with OpenCV, Keras, Tensorflow, and deep learning architecture. This system can be further enhanced and can be established at the entrance of almost all the public and private buildings like schools, colleges, hospitals, shopping malls, etc. This system will undoubtedly act as a valuable tool to strictly impose the use of a facial mask in public places for all people.

I. INTRODUCTION

The COVID-19 pandemic, also known as the coronavirus, is an ongoing epidemic of coronavirus disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Symptoms of COVID-19 highly vary from none to life-threatening illnesses. The pandemic has resulted in a significant global social and economic disruption. The virus spreads mainly through the air from the cough, sneeze or breathe of an infected person to others near them. It may also spread via contaminated surfaces. The WHO declared the outbreak a pandemic in March 2020. Every day an outsized number of individuals are being infected and died.

At the time of writing this paper, many strains of mutated viruses have discovered. As of March 2021, more than 121 million cases have been confirmed, with more than 2.69 million deaths attributed to COVID-19, making it one of the deadliest pandemics in history. The primary symptoms of coronavirus declared by the World Health Organization include Fever, dry cough, tiredness, diarrhoea, loss of taste, and smell. Recommended preventive measures to reduce the chance of infection include maintaining social distancing, wearing face masks in public, hand washing, covering one's mouth when sneezing or coughing, avoiding crowded places. Several vaccines are also being developed and distributed. But the number of COVID - 19 cases is increasing day by day.

The spread of the coronavirus can be limited if people strictly follow the most common precautionary measures like maintaining social distancing and wearing facial masks. Very bitterly, people are not obeying these rules properly which is speeding the spread of this virus Detecting the people who are not wearing masks in public places and warning them can be a solution to reduce the spread of the virus.

A face mask detection system is a technique to find if a person is wearing a mask or not. Deep learning architecture has a remarkable role in object detection. This architecture can be used for detecting the face mask.

This paper aims at designing a face mask detection system with OpenCV, Keras, Tensorflow, and deep learning. The system finds if the people in a smart city are wearing a mask or not. It also alerts the people by ringing an alarm if they are not wearing a mask. The language used to develop this system is python and the algorithm used is CNN (Convolutional Neural Networks). The web camera is used to obtain the input source as real-time video footage for this system. The facial images are extracted from that video footage and these images are used to identify the face mask. Whenever the architecture identifies people without face masks, an alarm is rung to alert that person. The proposed

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system has given expected output on data collected from different sources. Also, this system ensures that the people will follow the basic health guidelines enforced by the government for this pandemic.

II. PROPOSED SYSTEM

Several systems have been developed for detecting face mask for the sake of the COVID-19 pandemic. In most of the existing systems, a person is categorized as "wearing a mask" even if he/she isn't wearing it properly (i.e., both nose and mouth not properly covered). And in some cases, there are difficulties in classifying faces covered by hands since it almost looks like the person wearing a mask.

On the whole, these systems do not take any sort of automatic actions to warn the people without a mask. This could be a major drawback for the system.

Fig 1:Various configurations related to the mask wearing

In Fig 2, the proposed system, there are no difficulties in classifying faces covered with objects other than a mask. It also makes sure that a person is considered to be wearing a mask, only if he/she is wearing it properly by fully covering his/her nose and mouth (as in Fig 1). This is because, the images undergo a step called image preprocessing, in which the images are transformed into a grayscale image of array format to eliminate a few redundant information and to obtain only the necessary information for classification. Then the deep learning architecture learns the important features from the given samples. These samples are dataset collection containing several images of faces with and without masks. It is used for training and testing the model.Finally, the system also alerts the people who aren't wearing a mask or not wearing a mask properly by ringing an alarm. This system will be a useful tool to reduce the spread of coronavirus disease in almost all countries in the world.

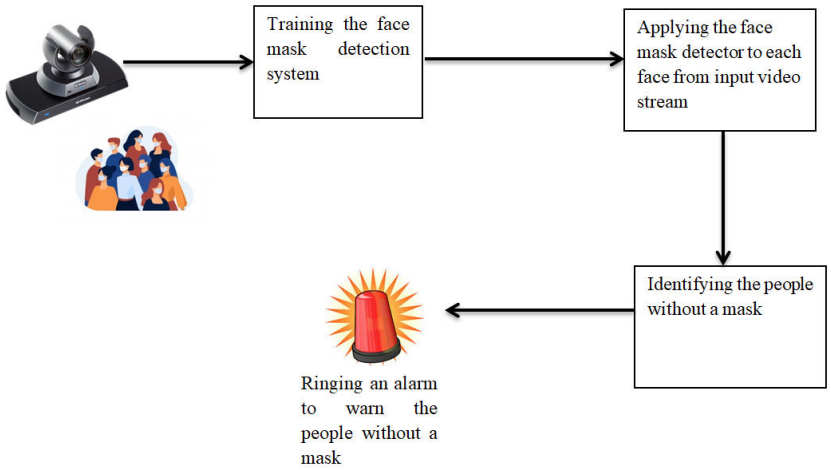

Fig 2: Overview of the proposed system

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The motivation for this paper came from the people all over the world, who are violating the rule of wearing a mask in public places. This may be because of lack of knowledge or awereness. But it is necessary to monitor the people and to alert them to wear a mask everytime they step out of their home.

III. SYSTEM ANALYSIS

We have proposed an automated smart system for detecting people with and without mask. A web camera is used to capture the input image from a real – time video footage. Then these images are fed into a system to identify, if the person appearing in the image is with or without a facial mask. Only if any person without a mask is been detected, then an alarm is set to ring in order to alert that person to wear a mask. The algorithm used to develop this system was CNN (Convolutional Neural Network). After studying about the different algorithms of Deep Learning, we used CNN in our project, since it is more efficient. In Fig 3, the python script used to develop this system is divided into twophases – training and applying the face mask detection system.

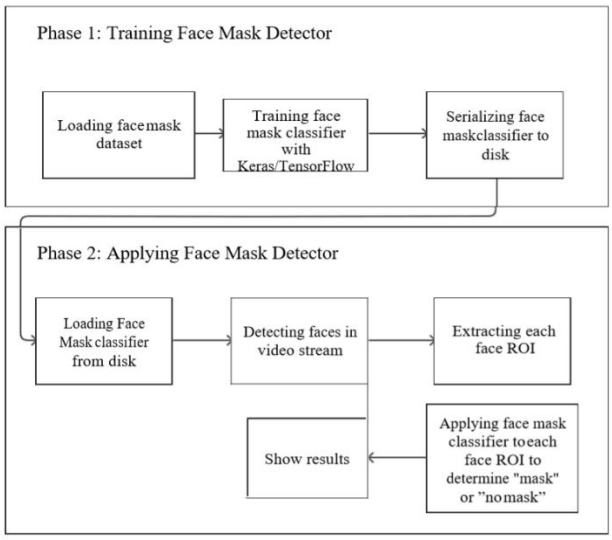

Fig 3: Phases and steps involved in building our face mask detection system.

These phases of the system are described as follows:

A. Training:

In Fig 4, data from different sources are collected for training and testing the model. This dataset consists of 3,833images belonging to two classes - with_mask : 1,915 images and without_mask : 1,918 images.

The very first step is preprocessing the images of the dataset. In this step, the image is transformed into a grayscale image because the RGB color image contains so much redundant information that is not necessary for face mask detection. RGB color image stored 24 bit for every pixel of the image. On the other hand, the grayscale image stores 8 bit for each pixel and it contained sufficient information for classification. Then, we resized the images into 224×224 pixels to maintain uniformity of the input images to the architecture. Then, the images are normalized and after normalization, the value of a pixel resides in the range [-1, 1]. Normalization helped the training algorithm to find out faster and captured necessary features from the pictures. This step also ensures that the training data is converted into Numpy array format.

B. Deep Learning Architecture:

The deep learning architecture learns various important non-linear features from the given samples. To train our deep learning architecture, we collected images from different sources. The architecture of the learning technique highly depends on Neural Networks. The deep learning architecture in this system has two phases. They are described below.

i. Training phase:

In Fig 3, data from different sources are collected for training and testing the model. For training purposes, 80% images of each class are used and the rest 20% of the images are utilized for testing purposes. For training, we

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have applied on-the-fly mutations to our images in an effort to improve generalization. This is known as data augmentation.

Fig 4: Sample images 'with_mask' and 'without_mask' from the dataset used

ii. Deployment phase:

The system is loaded with MobilNetV2 classifier to perform fine-tuning to establish a baseline model to save considerable time. The learning model is predicted on CNN which is extremely useful for pattern recognition from images. The network comprises an input layer, several hidden layers, and an output layer. The hidden layers consist of multiple deep layers that learn suitable filters for important feature extraction from the given samples. The features extracted by CNN are used by multiple neural networks for classification purposes. The architecture contains three pairs of layers each followed by one Average pooling 2D layer. This layer decreases the spatial size of the representation and thereby reduces the amount of parameters. As a result, the computation is simplified for the network.Then, a flatten layer reshapes the information into a one-dimensional array to feed into the dense network. The dense layer comprises a series of neurons each of which learns non-linear features. The dropout layer prevents the network from overfitting by throwing in the towel units. Finally, a dense layer containing two neurons distinguishes the classes. With that, the loss and accuracy curves of the training and testing phases are plotted.

C. Ringing an alarm:

The main goal of our proposed system is detecting persons who are not following guidelines of using a facial mask. The learning architecture identifies whether any input image contains persons without a mask. If such a person is detected, then an automated alarm is set to ring to warn that person. The alarm is rung by installing and extracting the PyAlarm in this system.

IV. RESULTS ANALYSIS

In Fig 5, the developed architecture is trained for 100 epochs since further training results cause overfitting on the training data. Overfitting usually occurs when a model learns the unwanted patterns of the training samples. Hence, training accuracy increases but test accuracy decreases.

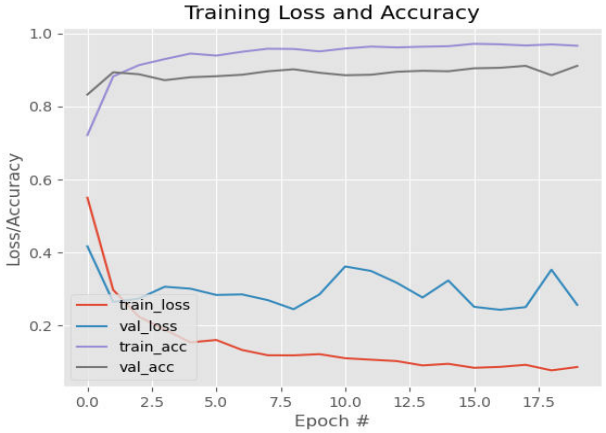

Fig 5: Training Loss and Accuracy curves

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The trained model showed 89% accuracy and AUC of 0.895 on the unseen test data (as in Fig 6).

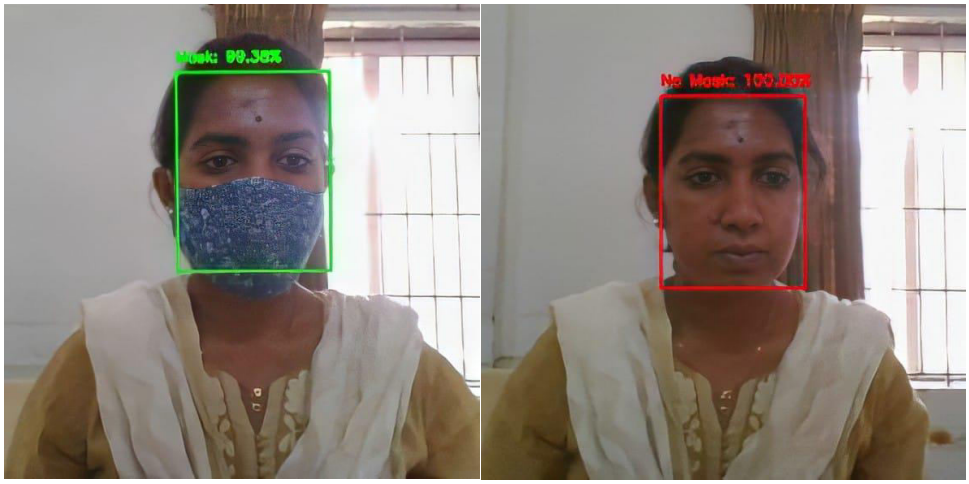

Fig 6: Output for 'with mask'and 'without mask'

V. CONCLUSION AND FUTURE WORK

The proposed system will be able to detect more than one face at a time. This could be a great advantage for any other system. But in our case, when more than one face is being detected at the same time and if one face is with a mask and the other is without a mask, then there arises a confusion whether to ring the alarm or not. So in order to avoid such confusion, it is better if only one person passes through the camera at a time.

This system can be further enhanced by replacing the web camera with a CCTV camera and also the alarm can be rung with a buzzer connected to the system via an Arduino board. This enhanced system can be established at the entrance of many public and private buildings like schools, colleges, hospitals, shopping malls, etc., to check whether a person has worn a facial mask before entering the respective buildings.

This system provides a smart way to reduce the spread of coronavirus by detecting and alerting the person who is not wearing a facial mask that is a precautionary measure of COVID-19.

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