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Face Mask Detection using Combination of Classification and Object Detection

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Abstract: ***In this paper, we have created a system to detect whether a person is wearing a mask or not in public places like the mall, where we have CCTV cameras. The result can be shared with different screens so that others can prevent themself from that person or officials can charge the respective person. The system aims to prevent viral transmission in case of any pandemic.***
Keywords: CNN, Feature extraction, Image classification, Transfer learning, Object Detection

I. INTRODUCTION

Due to COVID-19 people are dying and every day many people are infected by this virus. 220 countries are affected by the coronavirus, including all of the developing countries like India, USA, UK, Russia, China, Japan, Italy, etc. According to the report, in 220 [17] countries around the world, a total of 176,050,907 infected have been confirmed and more than 3,800,841 people have died from this virus. The major cause of infection was carelessness. Every day people ignoring Covid Guidelines are spreading the virus to other people. Even after taking their vaccine people can get affected by covid [16]. It's very difficult to surveillance each person whether he is properly following Covid guidelines, Police or government officials can't be surveillance to everyone at all time as it is very time-consuming and very difficult. This research mainly helps to solve this problem by publicly showing the faces of people who are not following the guidelines. Either police can take action on them or they can prevent themselves by following guidelines. Especially in COVID-19, it's an important thing to save ourselves from other peoples. Nowadays this security system is increasing which leads to a remarkable change in our daily life. Therefore, the Security System has a crucial role to safeguard people. Face Mask Detector is one of the research areas among practical applications. It may be used in the area of law enforcement for surveillance. It monitors the people who didn't wear the mask and we can further use these images for improving our system.

II. RELATED WORKS

P. Viola et al. [1] discussed a face detection framework that is capable of detecting faces rapidly over the high detection frame rate. The research paper done by three contributions is an integral image, built using an efficient classifier by AdaBoost learning algorithm and lastly combining a classification into the cascade for background region.

Viola-Jones' locator improved the highlights of Haar, yet neglected to handle this present reality issue and was impacted by different components like face brilliance and face direction. It solely detects the frontal sufficiently bright faces and also fails to work in a dark environment and with a non-bright face image. The specialist said if people wear masks, the spreading of COVID-19 will minimize [2].

X. Liu and S. Zhang [3] described the place of origin and the history of the coronavirus. They also described the protection of the coronavirus by wearing a mask, but their paper didn't have any proposed model and didn't use any algorithm.

M. Loey et al. [4] worked with GAN for the detection of coronavirus in chest x-ray images using deep learning. The lack of a dataset for detecting coronavirus in the chest x-ray sector was the main motivation of this paper.

M.K.J. Khan et al. [5] worked to remove the microphone object from the face of an image. They used the MORGAN method to solve this problem. Their work is divided into two stages, one is painting and the other is a refiner.

S.A. Hussain et al. [6] worked to detect and recognize images using HaaR cascade with the support of Keras, CNN. They had three phases where the first phase detected the human face from the camera, the second phase analyzed the captured image, and the third phase classified the face with their emotions i.e. sad, happy, neutral or angry, etc.

Z. Wang et al. [7] described three types of mask face datasets, those are MFDD, RMFRD, and SMFRD. M. Kawulok et al. [8] described face detection and analysis of face using deep learning. Their aim was facial analysis, deception detection, various physiological disorder prediction, etc.

L.Wen et al. [9] system can detect fault diagnosis with the help of deep learning. Focused on ImageNet and ResNet-50 provided higher accuracy where they showed their accuracy of 99.99% using TCNN (ResNet50).

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P. Gupta et al. [10] proposed a model using CNN which can detect and recognize a human face at a time. Their work showed 97.05% accuracy with the help of Yale's face detection dataset.

L.Wang et al. [11] paper showed facial recognition with the help of LBPH for surveillance and anti-theft security purposes. In their work, they also used drone technology systems to give an extra boost to their surveillance.

Z. Abidin et al. [12] discussed facial expression recognition using fisher face, where the accuracy achieved 89.20%.

P. Pattanasettanon et al. [13] proposed a system that recognizes a face with the help of an eigenface. They also focused on special regions of the face as nostril areas and oral areas, although they had a small amount dataset, they achieved 100% accuracy for their work.

T. Schenke et al. [14] described a facial recognition system with the help of raspberry pi using CNN, KNN with eigenface, and SVM, where the SVM algorithm showed higher accuracy for facial recognition. Some limitations are detected on the existing models, where some works have limited dataset or they will not give security alert and does not work properly on mask face, so this work aims to detect mask face in this pandemic situation to prevent coronavirus.

Let see some limitations of existing models. A Novel Approach to Detect Face Mask using CNN [15] paper showed CNN to detect masked faces in a secured way and for establishing better surveillance, a security alert is deployed -for this and ensures the surveillance of the place. The used dataset is available and it is quite small but gives away a better accuracy.

III.APPROACHES

A. First Approach

In our first approach, we use the Haar Cascade Classifier method for face detection of the person. Through this approach, the first camera will read the image and then the system detects the face with the help of the Haar Cascade method. In the Haar cascade method, the system detects the nose and mouse of persons, if the nose and mouse are visible to the system then the system will highlight the face of the person not wearing a mask or vice-versa. Object Detection Haar Cascade Classifier method proposed by Paul Viola and Michael Jones.

In the Haar Cascade Classifier approach, a cascade function is trained from a lot of with mask and without mask images. In this approach, we consider adjacent rectangular regions at a specific location in a detection window, sum up the pixel intensities in each region, and calculate the difference between these sums. Then the differences are used to categorize subsections of an image. Using the Pattern Recognition method, this method detects triangles or any other shape on the mask as the nose, so it decreases the accuracy of this approach. Its accuracy is not even 30%. Using this approach, system performance is also very low.

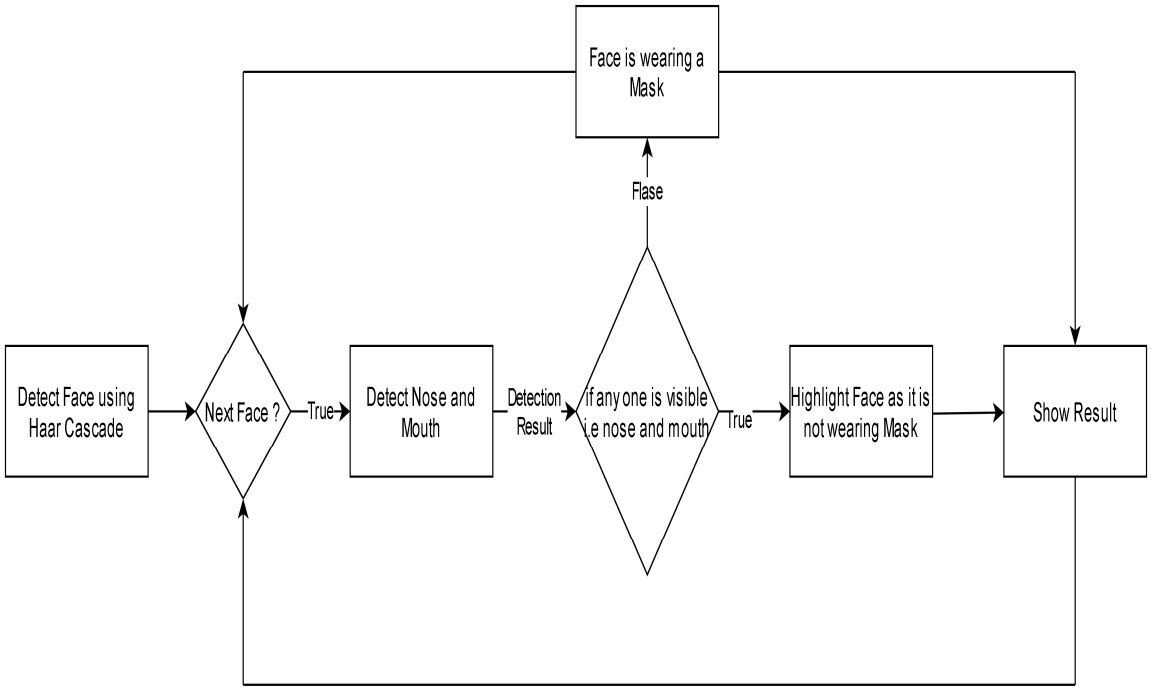


Fig. 1 Flowchart for second approach

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B. Second Approach

In the second approach, we used CNN (convolutional neural network). CNN approach can be used in image recognition and processing that is specially designed to process pixel data. CNN can use deep learning to perform both generative and descriptive tasks, often using machine vision that includes image and video recognition and recommender systems. A CNN uses a system much like a multilayer perception that has been designed for reduced processing requirements. The layers of a CNN consist of an input layer, an output layer, and a hidden layer that includes multiple convolutional layers, pooling layers, and fully connected layers. In this approach first, we have to train our system for training the dataset we take images. With the help of the Haar cascade classifier it extracts the face from the images after that we resize the face to a size that is required by CNN Classifier. We used the dataset to train our Model (CNN Classifier) which is MobileNet V2[20]. After training the model it will read the image from other sources like the camera and provide us whether the input image is wearing a mask or not.

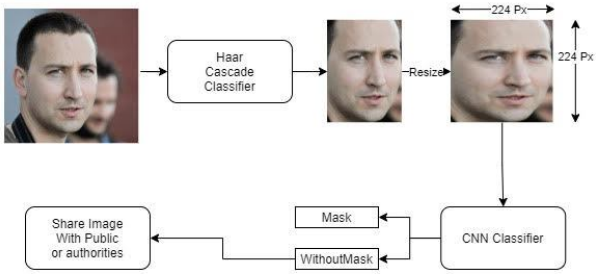


Fig. 2 Flowchart for second approach

C. Third Approach

In the third approach, we are using object detection using multiple algorithms like YOLO [21], SSD MobileNet V2 [20], etc. Object detection is the task of classifying and locating an object inside an image. Object detection techniques are used in applications such as picture retrieval, security cameras, and autonomous vehicles. YOLO is one of the most famous object detections in Deep Convolutional Neural Networks. In this system Image classification involves assigning a class label to an image, whereas object localization involves drawing a bounding box around one or more objects in an image. Object detection is more complex and it combines two tasks: classification and localization (drawing a bounding box). These two tasks happen to each object of interest for our scenario: it is the person's face.

To train a model object detection we used images and their respective label file. The label file can have different formats (XML, TXT) depending upon the Model, the label will contain the class (with mask and without mask) and the bounding box (Localization) of an object. After that input images are pre-processed that will depend upon the model used in the system. YOLO, SSD Mobilenet v2, and other algorithms divide the image into blocks, these blocks are used as a separate image for classification. After that model predicts the class and bounding box of the image. The predicted output from the model is passed for calculating the loss, the loss is calculated using the label file of the image, the goal of the training is to minimize this loss as much as possible.

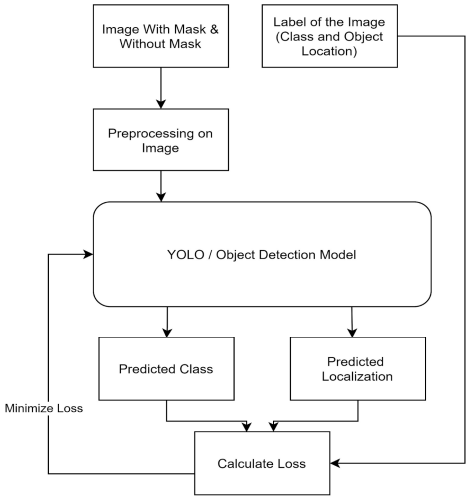


Fig. 3 Flowchart for training a Mask detection model using object detection

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IV. EXPERIMENTATION AND RESULT

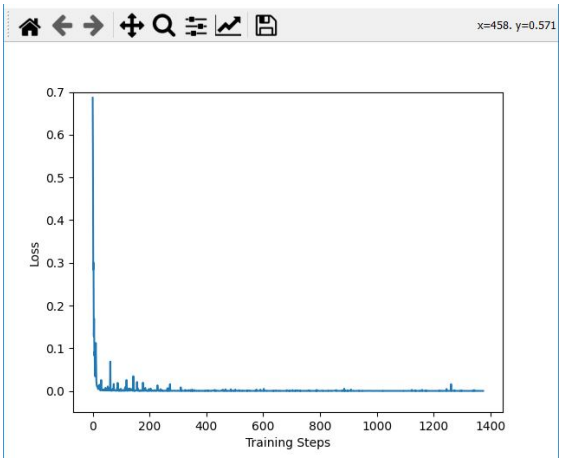


Fig. 4 Training Loss on the second approach

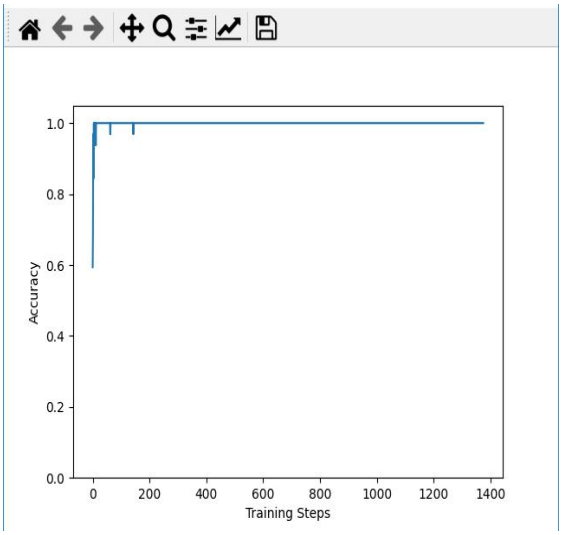


Fig. 5 Accuracy on the second approach.

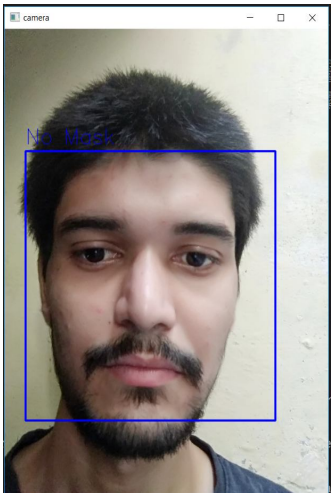


Fig. 6 Result of not wearing a mask on the second approach.

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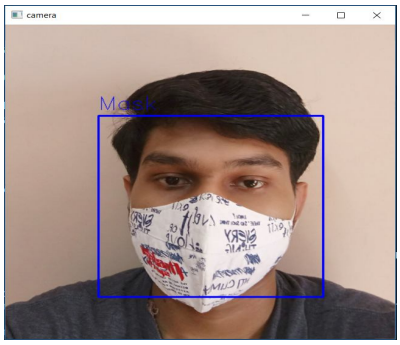


Fig. 7 Result of wearing a mask on the second approach.

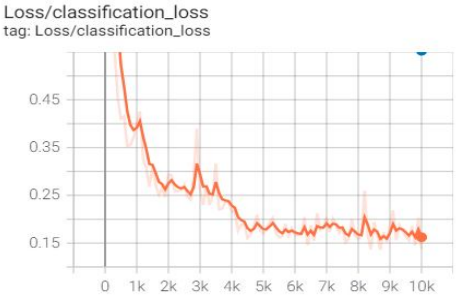


Fig. 8 Classification Loss using 3rd approach

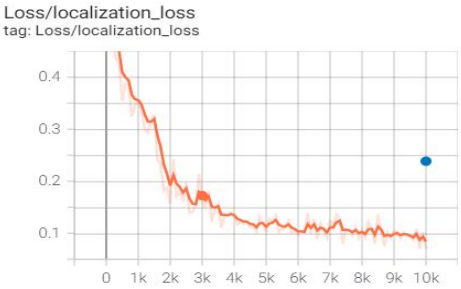


Fig. 8 Localization Loss using 3rd approach

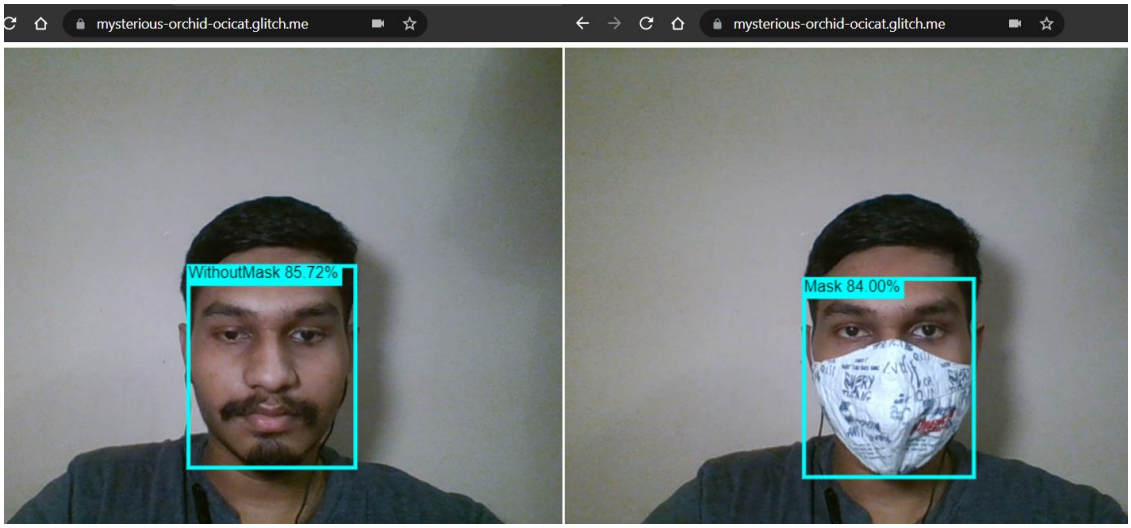


Fig. 9 Result of the Third approach using a Web App

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V. CONCLUSION AND FUTURE WORKS

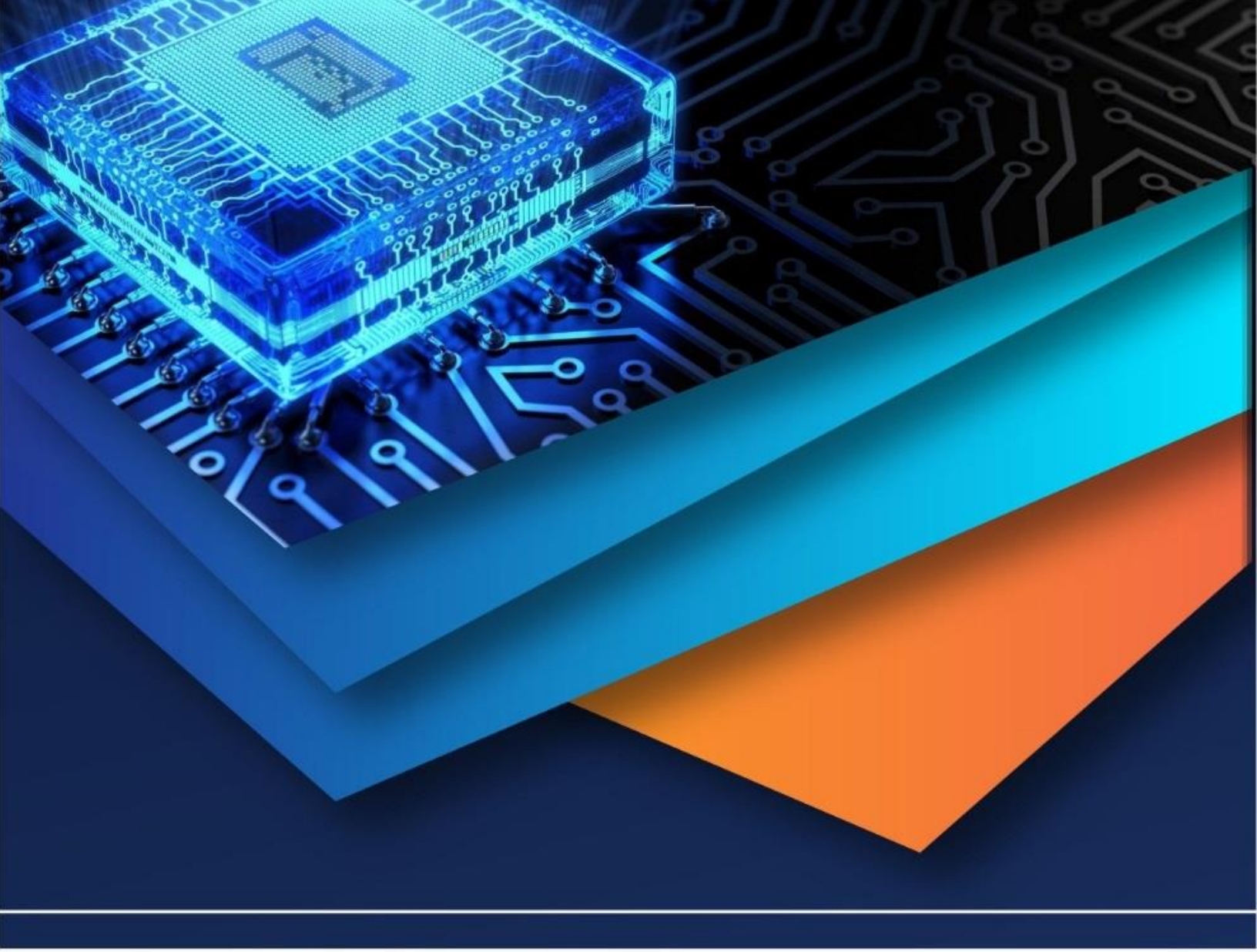
This research paper works with Haar Cascade Classifier, CNN, and Object detection with multiple algorithms like YOLO, SSD MobileNet V2 to detect the face of single or multiple people to identify if the person is wearing a mask or not. If the person is not wearing a mask, then the system will alert the authorized person and then they display an image on the big screen. The model can be used to find if people are wearing masks by capturing images and video recordings from the surveillance cameras. Instead of using people to check if other people, who are entering a place or moving around in an area are without a mask to prevent the virus from spreading.

The project can be further improved in such a way that anyone who wants to use our system can install it easily and without much configuration. The accuracy of the system can further be improved by training with more images. We can do some experimentation with different machine learning models to improve accuracy and performance.

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