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Survey on Face Mask Detection Using Machine learning

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Abstract*: The spread of Coronavirus started at the end of the year 2019 from the city of China, Wuhan. The continuous spread of the virus forced governments of various countries to put lockdown for several months. It has been observed that wearing a face mask can actually prevent the transmission of this deadly virus. In the future, we have to use a face mask as a preventive measure for any such viruses. However, manually it is very difficult to keep track of a person wearing a mask or not. And here technology plays a very crucial role. This paper highlights the importance of deep learning especially object detection. We introduce a deep learning model that will detect faces and can predict whether the person is wearing a mask ornot.*
Keywords *- MaskDetection, Covid 19, CNN, TensorFlow,Keras.*

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I. INTRODUCTION

Coronavirus disease which is known as Covid 19 is an airborne infectious disease caused by a newly discovered virus coronavirus. People who are already suffering from chronic diseases like Cancer, Diabetes are more likely to get affected with Covid 19 [1]. Before coronavirus people used to wear masks or scarfs for their own reasons like protecting the face from sunburn or to hide their emotions from the public. Scientists have finally proved that wearing a mask is a very good measure to prevent ourselves from Covid 19 [2]. For people who are already infected by a coronavirus, there are very high chances of spreading the disease when they talk or breathe. It is observed that coronavirus spread through fluid particles that are less than 0.0002 inches in diameter, which are usually emitted when people speak. This is why Coronavirus was spreading so fast in the beginning months of its spread [1]. Face Detection is one of the long-researched computer vision problems. In 2001, the Viola- Jones Face detector made it possible to detect faces. There is a number of classifiers in the Viola-Jones Algorithm from simple to very complex [3]. In the past few years, deep learning has made a huge breakthrough in computer vision areas, such as image classification, object detection, object segmentation. Like traditional algorithm's Convolution Neural Network (CNN) can automatically learn useful features from the training datasets [3]. Here we introduced a model using Deep Learning and Computer Vision that will be able to detect a person without a mask. This model can be embedded with the pre-installed CCTV cameras [4]. In this paper, we will also discuss the comparison between different algorithms and optimizers[3].

A. Computer Vision:

Computer vision is a form of Artificial Intelligence that leads computer to identify things using different algorithms. The algorithms are trained to collect predefined features helping the computer to pick objects out of the crowd. Social networking sites use computer vision to tag people in your photograph [2].

B. Deep Learning:

Deep Learning is a form of Artificial Intelligence inspired by the structure of the human brain. In terms of deep earning this structure is called a neural network. The features in deep learning are picked by the neural network. Deep Learning is nowadays very popular. The Neuron in a Neural Network is basically a function through which we predict the output [10]. The connection between Neurons that are performing some sub tasks for detecting an object is called a Neural Network. Neural Network is a trained network. A dense Neural Network is when every Neuron is connected to every other Neuron in other layers [5].

C. Backward Error Propagation:

It is a technique in which the model tries to learn from the feedback of the predicted output. Initially, the model will make some errors, and then it will change the weights to generate the correct output. Pytorch and TensorFlow are the two open-source deep learning framework. Pytorch is primarily developed by Facebook whereas, TensorFlow is developed by Google [12].

D. Convolutional Neural Network:

Convolutional neural network is a profound learning engineering that is utilized for face recognition. The Convolutional Neural Network (CNN) otherwise called ConvNet designs is made out of a gathering of layers depending on their usefulness

[4]. The organization can catch the spatial and transient conditions in a cluster through the utilization of fitting channels. It performs better separating in light of the decrease in the number of boundaries included and the reusability of loads [6]. Primary kinds of layers to assemble ConvNet models: Convolutional Layer, Pooling Layer, and Fully-Connected Layer. We will stack these layers to shape a full ConvNet design.

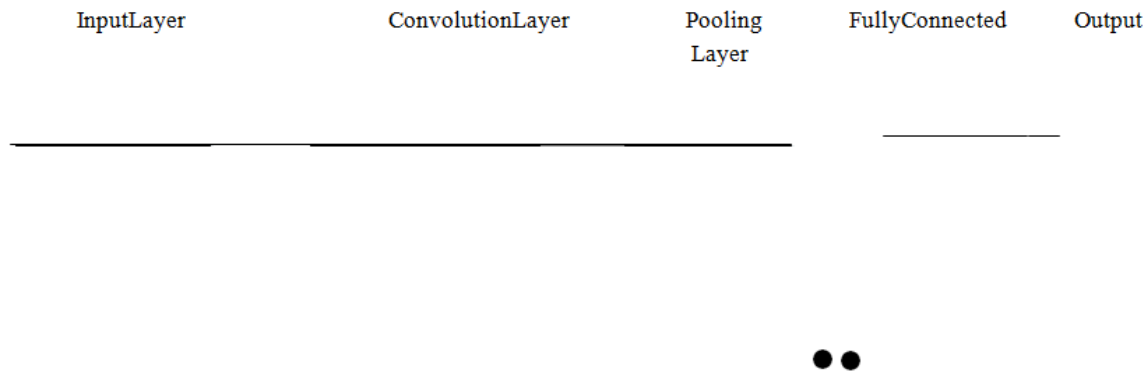

Fig. 1. Example of a Convolution Neural Network

E. ActivationFunctions:

The **activation function** of a node defines the output of that node given an input or set of inputs. In Neural Network, we have different types of activation functions. The step function is one of the activation functions, but this is not a good choice for multiple classifications [17]. And hence, the Sigmoid function is used. The sigmoid function should be majorly used in the output layer only and in hidden layers, the Tanh function should be used. Sigmoid and Tanh functions become very slow when the value is zero or negative. Therefore, the Relu function is very effective. The basic working of the Relu function is that it keeps all the positive values as it is but it changes all the negative values to zero[15].

II. LITERATUREREVIEW

The face mask detection model is very useful for public places like hospitals, airports, offices where a huge number of people travel from one place to another [1]. In hospitals, we can embed this model in pre-installed CCTV cameras. If the workers of the hospitals are found without mask alarm will ring and the higher authorities of the hospital can take necessary actions against the worker [3]. In airports, the entrance and exit gate of the airport should have this model. The System is prepared to recognize precisely whether an individual is wearing a mask or not [10]. At the point when the calculation recognizes an individual without a mask, caution ought to be produced to alarm the individuals around or the concerned specialists close by, so fundamental activities can be taken against such violators [4]. Not only for Covid19 pandemic, any place and at whatever point facemask is commanded to relieve any air-borne illnesses, passage, what's more, leave access frameworks can be incorporated with such innovation to help in diminishing the spread of infection [1]. The cameras are used to capture images from public places; then these images are feed into a system that identifies if any person without face mask appears in the image. If any person without a face mask is detected then this information is sent to the proper authority to take necessary actions [9]. The trained architecture [Table 1] with multiple layers of convolution and max-pooling connected to dense neural network achieved 98.7% accuracy on distinguishing people with and without a facial mask for previously unseen test data. The trained model showed 98.7% accuracy and AUC of 0.985 on the unseen test data[8].

Sr No.	Title	Advantages	Drawbacks
1.	Performance Evaluation of Intelligent Face Mask Detection System with various Deep Learning Classifiers	The system is evaluated with different classifiers. Different classifiers like MobileNetV2, RESNET50, VGG16, each of them was compared with Optimizers like ADAM, ADAGRAD, SGD to yield the highest accuracy. ADAM gave maximumaccuracy.	The best framework might be executed alongside interfacing with caution and alarming frameworks soon. This framework might be incorporated with a framework which can coordinate with a framework actualizing social distancing which can make it a healthy framework that can welcome emotional effect on the spread.

2.	Covid-19 facemask detection with deep learning and computervision	The system comprises of MobileNet as the spine which can be very well utilized for high and low calculation situations. In order to extract more robust features, learning is used to gain weights from a similar task face detection, which is trained on large datasets. The proposed method accomplishes state-of-art results on public face mask dataset. By the advancement of face mask detection, it can be detected whether a person is wearing face mask or not and permit their entry would be of great help to the society.	In future studies, a more extensive facemask wearing dataset including images and videos will be collected and labelled with more details in order to improve the performance.
3.	A Cascade Framework For Masked Face Detection	A deep-learning based algorithm for masked face detection is proposed. This algorithm is based on a recently planned CNN course structure comprises of three CNNs. Additionally, another dataset called "MASKED FACE dataset" is proposed which have 160 images for training and 40 images for testing. To defeat the overfitting issue due to lack of training samples, the model is pre-trained with WIDER FACE dataset, and finetuned them with MASKED FACE training set. This masked face detection algorithm is assessed on the MASKED FACE testing set, it achieves satisfactory results.	The system can be used in CCTV footages to identify whether a person is wearing a mask correctly so that he does not pose any hazard toothers.
4.	Multi-Stage CNN Architecture for Face Mask Detection	A two-stage face mask detector was introduced. First stage uses pre-trained RetinaFace model for face detection, after comparing its performance with Dlib and MTCNN. Second stage uses NASNetMobile based model for classifyingfaces as "masked" or "unmasked". Besides, centroid tracking is used to improve performance on video streams.	At present, the model gives 5 FPS inference speed on a CPU. We plan to improve this up to 15 FPS, making our model deployable for CCTV cameras, without need of a GPU. Stage 1 and stage 2 models can be easily replaced with improved models that would give better accuracy and lower latency.
5.	Deep Learning Framework to Detect Face Masks from Video Footage	In this work, methodology for recognizing face masks from videos is proposed. A profoundly successful face identification model is utilized for getting facial pictures and signals. A particular facial classifier is constructed utilizing deep learning for the errand of deciding the presence of a face mask in the facial pictures distinguished. The subsequent methodology is strong and is assessed on a custom dataset got for this work. The proposed approach was discovered to be successful as it depicted high exactness, review, and precision esteems on the picked dataset which contained videos with fluctuating occlusions and facial angles.	Mass screening is little difficult in crowded places like railway stations, bus stops, streets, schools, colleges, etc. so the system yielding better accuracy can becreated.
6.	A convolutional neural network (CNN) approach to detect face using tensorflow and keras	A deep convolutional neural network (CNN) is utilized to extricate highlights from input pictures. Keras is utilized for actualizing CNN additionally Dlib and OpenCV for adjusting faces on information pictures. Face acknowledgment execution is assessed utilizing a custom dataset.	Facial acknowledgment is a powerful apparatus that can help law makers perceive lawbreakers and software organizations are utilizing the innovation to help clients access their innovation. This innovation can be additionally evolved to be utilized in different avenues like ATMs, getting to private records, or other sensitive materials. This can make other safety efforts, for example, passwords and keys obsolete. Another way that innovators are looking to execute facial acknowledgment is inside subways and other transportation outlets. They are hoping to use this innovation to use faces ascredit cards to pay for our transportation charge.
7.	A Review on Face Mask Detection using Convolutional NeuralNetwork	By the improvement of AI and image processing analysis present strategies for mask detection. By utilizing image processing analysis and AI technique is utilized for finding out mask detection. Face mask identification can be done through different strategies. Essentially convolutional neural network technique is utilized quickly. The precision and decision making are exceptionally high in CNN contrasted with others.	Facial mask detection and non- masked face detection accuracy provided high variations.

8.	An Automated System to Limit COVID-19 Using Facial Mask Detection in Smart CityNetwork	In this work, a framework is proposed that confine the development of Coronavirus by discovering individuals who are not wearing any facial mask in a smart city network where all the public spots are checked with Closed-Circuit Television (CCTV) cameras. While an individual without a mask is identified, the corresponding authority is informed through the city network. A deep learning design is prepared on a dataset that comprises of pictures of individuals with and without masks gathered from different sources. The trained architecture accomplished 98.7% precision on recognizing individuals with and without a facial mask for previously unseen testdata.	The created framework faces challenges in arranging faces covered by hands since it nearly resembles the individual wearing a mask. While any individual without a face mask is going on any vehicle, the framework can't find that individual accurately. For a thickly populated zone, recognizing the face of every individual is troublesome. For this sort of situation, recognizing individuals without face mask would be very hard for the proposed framework. To get the best result out of this framework, the city should have an enormous number of CCTV cameras to screen the entire city as well as dedicated manpower to uphold appropriate laws on the violators. Since the data about the violator is sent through SMS, the framework fails when there is an issue in thenetwork.
9.	Masked Face Recognition Dataset and Application	It is urgent to improve the acknowledgment execution of the current face recognition innovation on the masked faces. Most current progressed face acknowledgment approaches are planned dependent on deep learning, which rely upon an enormous number of face samples. Notwithstanding, at present, there are no freely accessible masked face recognition datasets. To this end, this work proposes three sorts of masked face datasets, including Masked Face Detection Dataset (MFDD), Real world Masked Face Recognition Dataset (RMFRD) and Simulated Masked Face Recognition Dataset (SMFRD). Among them, to the best of our knowledge, RMFRD is as of now the world's biggest real-world masked face dataset. These datasets are freely accessible to industry and the academia, based on which different applications on masked faces can be created. The multigranularity masked face recognition model created accomplishes almost 95% accuracy, exceeding the outcomes reported by theindustry.	MFDD, RMFRD and SMFRD datasets are built, and built up a state-of-the-art algorithm dependent on these datasets. The calculation will serve the utilizations of contactless face authentication in local area access, campus management, and enterprise resumption scenarios. This exploration has contributed logical and innovative capacity to the avoidance and control of Covid epidemics and the resumption of creation in industry. Moreover, because of the continuous event of haze weather, individuals will frequently wear covers, and the requirement for face recognition with mask will continue for quite a while.
10	Fighting against COVID-19: A novel deep learning model based on YOLO-v2 with ResNet-50 for medical face maskdetection	The target of this paper is to comment on and confine the clinical face mask objects, all things considered, pictures. Wearing a clinical face mask in open territories, ensure individuals from COVID-19 transmission among them. The accomplished results presumed that the adam optimizer accomplished the most elevated normal accuracy level of 81% as a detector.	As a further study, it is intended to distinguish a kind of masked faces in picture and video based on deep learning models.

III. PROPOSEDSYSTEM

From the above survey, we saw different CNN models and their limitations. We will try to overcome those limitations and will build a better system. We are aiming to propose a system that will detect the faces without a mask from the input image or video stream. We are going to use computer vision and deep learning algorithms by using OpenCV, TensorFlow, and Keras. We are going to arrange the dataset from GitHub which will be classified into two categories i.e. With mask and without a mask. The total number of images in each category will be around 1200[Table 1]. We are going to perform training on 75 % of the dataset and the rest of the dataset will be used for testingpurposes.

Table I. Sample dataset size

Class Name	Description	No. of Images
Mask	Faces with masks Correctly used	1250
No mask	Faces with no masks	1300

The model will be prepared in 2 stages:
Stage 1:
1. Loading of the dataset in thesystem
2. MobileNetV2 classifier is used to train the data Stage2:
1. Load the classifier
2. Detect faces in the input image or videostream
3. Apply the trainedclassifier
4. The final output is generated by classifying as Masked Face or UnmaskedFace

We will use MobileNetV2 CNN to train the model with different layers of convolution and pooling operation. MobileNetV2 builds upon the ideas from MobileNetV1, using depth-wise separable convolution as efficient building blocks [2]. Before this, we are aiming to do data augmentation to increase our dataset for better performance. From the above survey, it is observed that ResNet gives the best performance as compared to other classifiers. With ResNet, as the network becomes deeper the training error actually reduces [7]. But the disadvantage of using ResNet is that it takes a huge amount of time to train, sometimes even weeks, and requires high computational power. Therefore, we are aiming to use Mobile Net V2 as its lightweight model. We have different optimizers in Keras like ADAM, ADAMAX, NADAM, SGD, ADAGRAD. Out of all these optimizers, it is found that the ADAM optimizer gives the best accuracy[7].

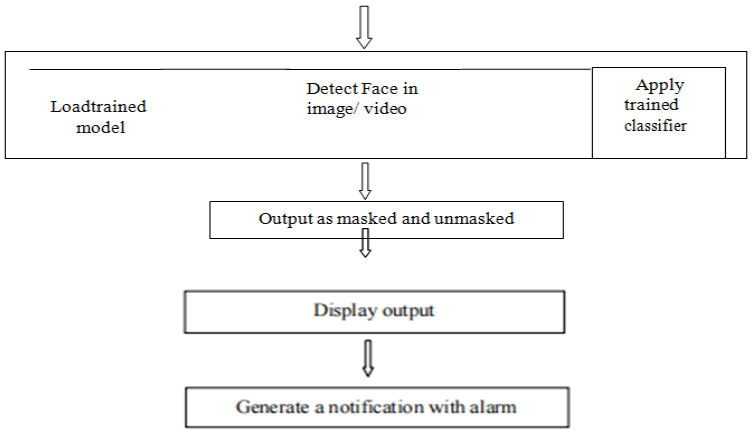

Fig. 2. Proposed system

IV. RESULTDISCUSSION

We will see the results of different classifiers with ADAM, ADAGRAD, and SGD optimizers [1].

Table 2. Results of the proposed system with MobileNetV2 classifier

Classifier	Epochs	Train/test size	Optimizer	Train loss	Train accuracy	Test loss	Test accuracy
MobileNetV2	20	90/10	ADAM	0.0090	0.9981	0.0071	1.0000
			ADAGRAD	0.2454	0.9148	0.1811	0.9819
			SGD	0.1549	0.9502	0.0216	0.9855

Table 3. Results of the proposed system with Resnet50 classifier

Classifier	Epochs	Train/test size	Optimizer	Train loss	Train accuracy	Test loss	Test accuracy
Resnet50	20	90/10	ADAM	0.0068	0.9975	0.0557	0.9856
			ADAGRAD	0.1087	0.9693	0.0019	1.0000
			SGD	0.1114	0.9693	0.0100	1.0000

Table 4. Results of the proposed system with VGG16 classifier

Classifier	Epochs	Train/test size	Optimizer	Train loss	Train accuracy	Test loss	Test accuracy
VGG16	20	90/10	ADAM	0.2145	0.9826	0.0006	1.0000
			ADAGRAD	1.7911	0.8425	0.4243	0.9638
			SGD	0.5133	0.9536	0.1055	0.9928

So, from above results we can say that ADAM optimizer gives us the best accuracy from rest of the optimizers [1]. Generally, it is observed that the performance of the model increases as it goes on becoming denser. MobileNetV2 yields high accuracy with low storage space and running time [9]. Generally, it is observed that the performance of the model increases as it goes on becoming denser. MobileNetV2 does not require much depth as compared to other networks such as Inception-v3, DenseNet201, ResNet50, VGG19. MobileNetV2 yields high accuracy with low storage space and running time.[21] MobileNetV2 does not require much depth as compared to other networks such as Inception-v3, DenseNet201, ResNet50, VGG19 So, we will build a system using ADAM optimizer and MobileNetV2 network as MobilevNetV2 is light weight and efficient to train [2]. We are aiming to design a system which will detect a face without mask and will generate a notification in the form of alarm [1]. In our architecture, we are going to train our model with different types of datasets because it is been observed that images captured in real-time i.e. Images captured through CCTV cameras are wider in size and also with low resolution. We will train the MobileNetV2 model with different classes of datasets like low-resolution images, wider images.

V. CONCLUSIONS

From the consequences of various classifiers, it is seen that ADAM optimizer's execution is generally excellent and the test exactness of SGD is roughly comparable to ADAM for all the 3 classifiers considered previously[1]. While testing, it is seen that the MobileNetV2 classifier is yielding the best outcomes with high precision[2]. This pandemic taught us the importance of social distancing, wearing masks, and following proper hygiene guidelines. The architecture will be designed using MobileNetV2 as a classifier as it is efficient to train. And we will use ADAM as an optimizer. We are aiming to design such a system that will not only detect the person without a mask but will also generate a notification in form of alarm. It will require TensorFlow, Keras, OpenCV, and CNN to detect a person with or without a mask. The model is tested with different images and real-time videos [2]. By development of such a model it will be very helpful to fight against viruses like Coronavirus in thefuture.

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