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Face Mask Detection Using Deep Learning

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***Abstract*—In late 2019, a VIRUS named COVID-19 spread initially from Wuhan, China to the world. During this period, many people were affected by this VIRUS. COVID-19 spreads when an infected person breathes out droplets and tiny particles containing the virus. Other people can breathe in these droplets and particles, or these droplets and particles can land on other people's eyes, nose, or mouth, resulting in infection from the VIRUS which results in the world getting affected by VIRUS so quickly. Here, the Face Mask Plays a Crucial Role in stopping the spreading of the VIRUS. For detecting the Face mask with the help of deep learning and images we have created a system that can determine if a person wears the mask properly, improperly, or has not worn any. For building this system we use One Dataset containing three types of Images a total of 853 images. With this system, we have been able to detect if a person wears the mask properly, improperly, or not wearing any mask with about 96**

***Index Terms*—COVID-19, VIRUS, Face Mask, Corona.**

I. Introduction

A. Problem Background

Among the diseases that spread through humans, coronavirus has caused the most epidemics. In 2019, the coronavirus first originated in the city of Wuhan, China. This virus spread all over the world and at one point the whole world was affected by the coronavirus.

The coronavirus can spread through people in several ways: through touch, through sneezing, through cough, and through close contact with an infected person. The face mask can help us in many ways to survive this pandemic virus. In this situation, we have created a system with the help of deep learning and machine learning that can determine whether a person is wearing a mask correctly, wearing a mask incorrectly, or not wearing any mask at all by watching images.

B. Problem Statistics

According to the World Health Organization [1] , nearly 7.1 million people have died from the coronavirus worldwide so far.

Wearing a mask can help you stay safe from this disease in many ways. A survey has shown that about 87,000 [2] people have been cured of the coronavirus just by wearing a mask properly, on the other hand 130000 [3] people have been infected with the coronavirus just by not wearing a mask.

We understand that in densely populated areas like shopping malls with traffic jams, the chances of contracting such diseases are much higher without wearing masks.

C. Tools and Technologies we have used to solve the problem

For image preprocessing, I have used the CLAHE (Contrast Limited Adaptive Histogram Equalization) for contrast enhancement and the Laplacian filter for edge enhancement, For better compatibility I have resized the image to 224*224 pixels lastly I've used normalization divided by 255

To solve this problem I have used code libraries and frameworks like tensor flow and Keras for the deep learning. Some pre trained CNN mndels like DenseNet 121, Dense Net 169 and DenseNet 201 as base model also I've used the Resnet152 V2, Xception, Mobile net V2. Scikit for metrics and data splitting the open CV (cv2) for image processing and lastly the SMOTE for and handling the class imbalance.

D. Data we have used to solve the problem

We can detect face mask detection in many ways whether a person is wearing a mask properly, not wearing it, or wearing it well. To better understand this, we have collected some data, taken from the Kaggle. Where the pictures of people from different times. Among the notable pictures are pictures of people from different angles, such as during the day, at night, from the front, from the side, and from different angles. for the analysis of data I took the help of data augmentation

where some adjustment is done like rotation, inversion, color adjustment, etc., each image represents a different class, for example, masked, unmasked, and improperly masked.

To separate the significant images, we took the help of .CSV files from within the data set. Together, we can build the system using the above data and deep learning.

E. My core contribution

The core contribution of this study is the development of a deep learning-based face mask detection system that accurately classifies individuals into three categories: mask-wearing, mask non-wearing, and mask-wearing incorrectly. We have trained some models against a dataset from where we can get high accuracy and thus it makes itself suitable for real-world applications. The study also deals with problems including data imbalance, and lighting variations, which makes this model more reliable and robust.

F. Outline of the Paper

The current section provides the Introduction to the paper. The rest of the paper is outlined as the following: Section II describes the review of the related works. Section III provides a detailed explanation of the methodology adopted for this study.

II. Related Works

The COVID-19 pandemic has accelerated research in automated face mask detection systems, there is much existing work in face detection with the help of deep learning. We will review some similar research papers and compare ours with all others in several key areas i.e. the data they have used, the models they have used, and lastly their limitations.

A.

According to Muhammad Usama, Muhammad Umar Karim Khan, and Muhammad Imran in their approach "A Novel DeepMaskNet Model for Face Mask Detection and Masked Facial Recognition [5]" they have developed an in-house unified Mask Detection and Masked Facial Recognition (MDMFR) dataset containing both masked and unmasked facial images of 226 individuals with diverse attributes. In their development, they proposed a novel DeepMaskNet model capable of reliable face mask detection and masked facial recognition. However, their existing research lacked a unified method and dataset to tackle both face mask detection and masked facial recognition problems

B.

According to S. Sethi, S. K. Sahu, and S. S. Rath in their study "Deep Learning Techniques for Detecting and Recognizing Face Masks [6]" they discuss multiple datasets, including NFW, IFW, and CFW, among others, to address the challenge of face mask detection. They utilized Convolutional Neural Networks (CNNs) such as SRCNet, YOLOv4, MobileNetV2, DenseNet121, and NASNet in their analysis. However, their work faced challenges, including dataset imbalances, lack of diversity, and difficulties in detecting improperly worn masks.

C.

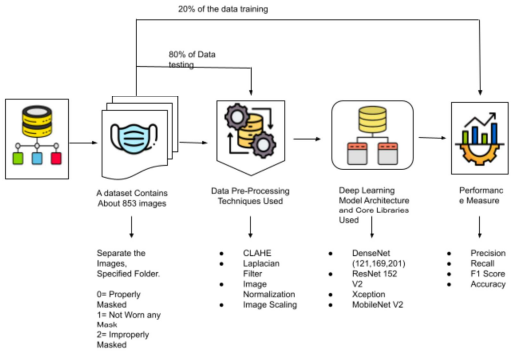
According to M. Loey, G. Manogaran, and M. H. N. Taha in their research "Face Mask Detection Using Deep Convolutional Neural Network and MobileNetV [7]," they utilized a dataset comprising 1,376 images with masks and 1,376 images without masks. They implemented a deep Convolutional Neural Network (DCNN) and MobileNetV2-based transfer learning models for reliable detection. However, their model's performance was affected by variations in lighting conditions and occlusions.

D.

According to A. K. S. Bhoi and P. K. Mallick in their review "Face Mask Detection in Smart Cities Using Deep and Transfer Learning: A Review [8]" they emphasized the importance of using large and diverse datasets for face mask detection. They explored various deep learning and transfer learning techniques to enhance detection capabilities. However, their study highlighted challenges, such as the scarcity of large-scale datasets and the need for models that can generalize well across different environments

III. Methodology

In this graph we can Say that the first step of our research begins with the data set collection for this research I have used the website named Kaggle [4]. From the Kaggle I used a dataset in which about 893 images after that I have prepared the data set separating the images in 3 major classes. The class zero includes properly masked pictures the class one includes not want any mask pictures and lastly the class two includes the improperly mugged pictures



IV. Result & Discussion

A. Best Result

The Below mentioned Table I have submitted has the best accuracy or result across all the test I have done the best result

is with 95% accuracy. The average AUC of this result is 0.9929 or 99.29% The best result have given by the dense net 169 with the Deep learning based custom classifier You can also see the precision, recall and the F1 score is very much impactful.

Feature Extractor	Classifier	Run	Accuracy	Precision			Recall			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
DenseNet169	Custom Classifier	1	95.23%	0.9730	1.0000	0.8714	1.0000	0.9924	0.9929	0.9929
		2	96.56%	0.9520	0.9950	0.9000	0.9990	0.9910	0.9920	0.9929
		3	95.21%	0.8500	0.9100	0.8500	0.9990	0.9800	0.9810	0.9929

B. All the Results

In this below section I have submitted all the tables which I have tested with my system I have used some feature extractor such as DenseNet (121, 169,201), ResNet152 V2, Xception, MobileNet V2 and for the Classifier I have used the Deep Learning Based Custom Classifier, SVP (Support Vector Machine), EGB (Extreme Gradiant boost), and Last Random Forest.

TABLES OF ALL RESULTS

Feature Extractor	Classifier	Run	Accuracy	Precision			Recall			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
DenseNet121	Custom Classifier	1	94.00%	0.88	0.96	0.99	0.97	0.91	0.99	0.9939
		2	93.00%	0.85	0.97	1.00	0.99	0.83	0.97	0.9920
		3	93.79%	0.8571	0.9754	1.0000	0.9928	0.8500	0.9714	0.9835

Feature Extractor	Classifier	Run	Accuracy	Precision			Recall			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
DenseNet169	Custom Classifier	1	91.41%	0.9415	0.9815	0.9442	0.9928	0.9714	0.9796	0.9867
		2	94.03%	0.9118	0.9680	0.9928	0.9784	0.8643	0.9786	0.9836
		3	95.23%	0.8790	1.0000	0.9929	0.9928	0.8714	0.9929	0.9929

Feature Extractor	Classifier	Run	Accuracy	Precision			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
DenseNet201	Custom Classifier	1	92.12%	0.9426	0.8462	0.9858	0.9835
		2	95.94%	0.9067	0.9769	1.0000	
		3	93.56%	0.8544	0.9675	1.0000	

Feature Extractor	Classifier	Run	Accuracy	Precision			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
DenseNet201	SVM	1	88.07%	0.7711	0.9052	0.9927	0.9618

Feature Extractor	Classifier	Run	Accuracy	Precision			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
DenseNet169	SVM	1	88.07%	0.7711	0.9052	0.9927	0.9618

Feature Extractor	Classifier	Run	Accuracy	Precision			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
DenseNet121	SVM	1	88.07%	0.7711	0.9052	0.9927	0.9618

Feature Extractor	Classifier	Run	Accuracy	Precision			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
DenseNet201	EGB	1	92.36%	0.8253	0.9829	0.9926	0.9734

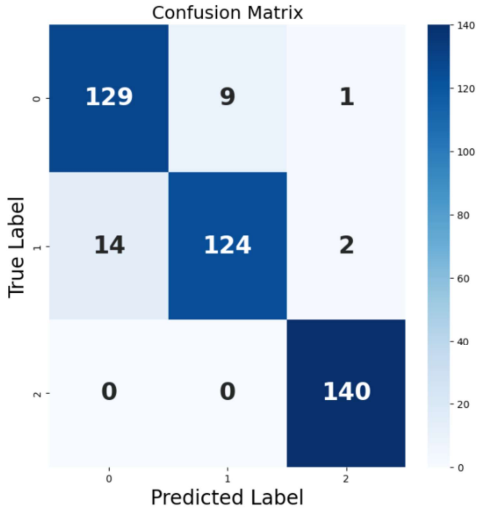
Feature Extractor	Classifier	Run	Accuracy	Precision			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
ResNet152 V2	Random Forest	1	89.98%	0.8081	0.9725	0.9565	0.9595

Feature Extractor	Classifier	Run	Accuracy	Precision			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
Xception	Random Forest	1	89.02%	0.9524	0.9381	0.9416	0.9524

Feature Extractor	Classifier	Run	Accuracy	Precision			AUC (Average)
				Properly wearing Mask	Not wearing a mask	Improperly wearing Mask	
MobileNetV2	Random Forest	1	89.26%	0.7977	0.9464	0.9701	0.9570

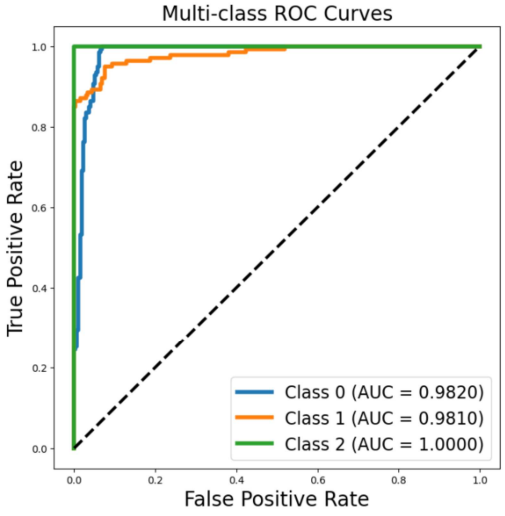
1) Confusion Matrix: In this Section we have shown how much the system has able to perform its task by confusion matrix multiclass roc curves training and validation matrices.

Here you can see the result of the confusion matrix is very much satisfied.

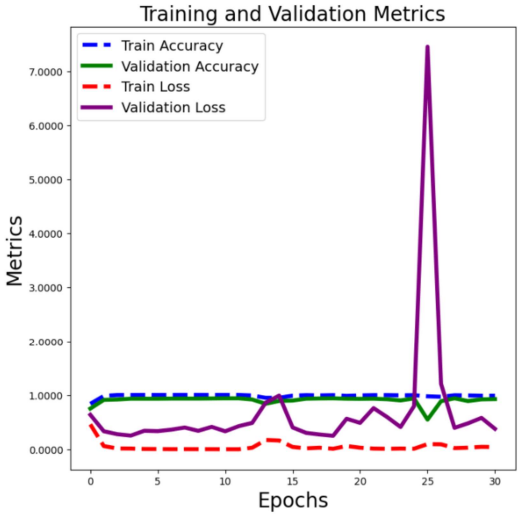


C. Multi-Class ROC Curves

Here you can see the multi class ROC Curves. And as a result you can see there also the AUC values having the Properly wearing Mask: 0.9820, Not wearing a mask: 0.98910 lastly the Improperly wearing Mask: 1.0000 with impactable result.



And lastly here is the training and validation matrices in which you can see that when accuracy validation accuracy train loss and validation loss there are all the curves in this matrices.



V. Future Work

To make this system more advanced We want to use motion detection technology afterward which can detect face masks in real time. Also, we want to use this system as much as possible in a crowded area just like a shopping mall or in traffic jams and many other places, so that we can reduce the chances of getting affected by covid 19 or any other harmful diseases.

VI. Conclusion

The developed system with the help of deep learning for the classification of whether anyone uses face masks properly, improperly, or does not wear face masks at all. This system uses a dataset of 853 images and achieves an impressive accuracy of 96% which could be a useful tool for public health monitoring and may be used in assisting the prevention of COVID-19 transmission. To receive this awesome result I have used the DenseNet169 as a feature extractor and I have used a deep learning-based custom classifier.

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