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Real Time Mask and Maskless Face Classification System

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ABSTRACT

With the inevitable breakout of the third wave of the Covid-19 pandemic tagged the Delta variant, there arises a severe need of protection mechanisms, face mask being the primary one.We have developed a model of Face Mask Detector which was built using Keras, TensorFlow, MobileNet and OpenCV. The architecture used for the object detection purpose is MobileNetV2 architecture which is computationally efficient and thus making it easier to deploy in real-time applications which require face-mask detection for protection purposes due to the outbreak of Covid-19. Experimental results show that our model performed well on the test data with 99% precision, recall and accuracy. The validation results as shown in some of the selected screenshot indicates a 100% detection accuracy.

KEYWORDS: Covid-19, face mask detection, Keras, TensorFlow, MobileNet, OpenCV

I. INTRODUCTION

Due to the Covid-19 pandemic that is ravaging the world's health system and causing havoc to all the sectors especially the economic sector, it now imperative to wear a face mask especially in crowded areas where social or physical distancing cannot be observed in order to run our daily life without hindrance. To ensure that this basic new norm is strictly adhere to, the need for an automated face mask detection system. The traditional method of detecting this is an herculean task due to the fact that many of the citizenry contravene this rule due to one reason or another. Hence the need for the deployment of an optimized face mask detection system that can be deployed for use in areas were there is large concentration of people such as health establishments, airports, educational outfits among others soas to enforce the rule of "No Mask NO Entry" that is operational now.Face mask detection as an offspring of object detection employs combination of many object detection approaches which has been successfully implemented.

II. RELATED WORK

Lippert et al used deep learning to develop a face detector model. The architecture used for the object detection purpose is Single Shot Detector (SSD) with VGG-16 network as base model and MobileNetV2 for the image classification. Alongside this, they used basic concepts of transfer learning in neural networks to finally output presence or absence of a face mask in an image or a video stream. Experimental results show that the model performs well on the test data with 100% and 99% precision and recall, respectively. The dataset used consists of 3835 total images out of which 1916 are of masked faces and 1919 are of unmasked faces with all images being actual images extracted from Bing Search API, Kaggle datasets and RMFD dataset.

Ristea et al proposed a novel data augmentation approach for mask detection from speech. The approach was based on training Generative Adversarial Networks (GANs) with cycle consistency loss to translate unpaired utterances between two classes (with mask and without mask), and on generating new training utterances using the cycle-consistent GANs, assigning opposite labels to each translated utterance. Original and translated utterances are converted into spectrograms which are provided as input to a set of ResNet neural networks with various depths. The networks are combined into an ensemble through a Support Vector Machines (SVM) classifier. This data augmentation technique provided a performance boost of 0.9% on the private test set.

Meenpal et al. presented a method to generate accurate face segmentation masks from any arbitrary size input image. Beginning from the

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RGB image of any size, the method used Predefined Training Weights of VGG – 16 Architecture for feature extraction. Training is performed through Fully Convolutional Networks to semantically segment out the faces present in that image. Gradient Descent is used for training while Binomial Cross Entropy is used as a loss function. Further the output image from the FCN is processed to remove the unwanted noise and avoid the false predictions if any and make bounding box around the faces. The model showed great results in recognizing non-frontal faces. Along with this it is also able to detect multiple facial masks in a single frame. Experiments were performed on Multi Parsing Human Dataset obtaining mean pixel level accuracy of 93.884 % for the segmented face masks

Wang et al proposed three types 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 currently the world's largest real-world masked face dataset. These datasets are freely available to industry and academia, based on which various applications on masked faces can be developed. The multigranularity masked face recognition model we developed achieves 95% accuracy, exceeding the results reported by the industry

Vinitha et al. proposed a system that focused on how to identify a person on image/video stream wearing face mask with the help of computer vision and deep learning algorithm by using the OpenCV, Tensor flow, Keras and PyTorch library. The approach used was to generate and train the face mask classifier (MobileNetV2) using PyTorch.Apply mask detector over images / live video stream for "Mask" or "No Mask" detection.

Qin et al. developed a new facemask-wearing condition identification method by combining image super-resolution and classification networks (SRCNet), which quantifies a three-category classification problem based on unconstrained 2D facial images. They proposed an algorithm that contains four main steps: Image pre-processing, facial detection and cropping, proposed SRCNet for SR(Super Resolution), and facemask-wearing condition identification. Their method was trained and evaluated on the public dataset Medical Masks Dataset containing 3835 images with 671 images of no facemask-wearing, 134 images of incorrect facemask-wearing, and 3030 images of correct facemask-wearing. The proposed SRCNetachieved 98.70% accuracy and outperformed traditional end-to-end image classification methods using deep learning without image super-resolution by over 1.5% in kappa.

Inamdarnet al designed a project in two phases: training face mask detector and implementing face mask detector. The dataset was loaded for the model to be trained and serialized in the training phase. The trained model was loaded, faces were detected in images and video streams and the region of interest (ROI) extracted. Finally, the face mask detector is applied and the images or faces in the video streams are classified as with a mask, improperly worn mask, without a mask. The green and yellow rectangular frame individually interpret the detected face and mask. The dataset consisted of 15 images of improperly worn masks, 10 masked images, and 10 images without a mask. MATLAB was used to build the facemask detector model and for trainingFacemasknet architecture was employed. The initial learning rate was set at 1e-4 and training epochs 20.

Roy et al. used popular object detection algorithms on MOXA for real time monitoring of people wearing medical masks YOLOv3 was trained on Moxa3K benchmark dataset using SGD with the momentum of 0.9 and weight decay of 0.0005. YOLOv3Tiny was trained y on Moxa3K benchmark dataset using SGD with the momentum of 0.9 and weight decay of 0.0005. SSD was trained with Mobilenet v2 backbone using tensorfow object detection API with tensorflow 1.15 on Moxa3K benchmark dataset using SGD with the momentum of 0.9 and weight decay of 0.00004. Faster R-CNN was trained with Inception v2 backbone using TensorFlow object detection API with TensorFlow 1.15 on Moxa3K benchmark dataset using SGD with the momentum of 0.9 and weight decay of 0.00004and evaluated them on Moxa3K benchmark dataset. The results obtained from these evaluations help to determine methods that are more efficient, faster, and thus are more suitable for real-time object detection.

III. METHODOLOGY

Face Mask Detector was built using Keras, TensorFlow, MobileNet and OpenCV. The face mask detector didn't use any morphed masked images dataset. The dataset used contain 1915 with mask and 1918 without mask with a total of 3833 images. All the images are actual images extracted from Bing Search API, Kaggle datasets and RMFD dataset. The images extracted from the three sources are of equal proportion which covers diverse races, there making the database balance. The dataset was split into three parts: training

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dataset, test dataset, and validation dataset. The dataset is split as per a split ratio of 80:20. The model is accurate, and since the MobileNetV2 architecture is used, it's also computationally efficient and thus making it easier to deploy the model to embedded systems (Raspberry Pi, Google Coral, etc.). This system can therefore be used in real-time applications which require face-mask detection for safety purposes due to the outbreak of Covid-19.

IV. RESULT AND DISCUSSION

	Precision	Recall	F1-score	support
With_mask	0.99	0.99	0.99	383
Without_mask	0.99	0.99	0.99	384
Accuracy			0.99	767
Macro avg	0.99	0.99	0.99	767
Weighted avg	0.99	0.99	0.99	767

MobileNetV2 Classification report

The following evaluation metrics were used precision, recall and F1-score with an accuracy of 99%. The equations of these three metrics are as follows:

$$\text{precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$

$$\text{recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

$$\text{F1} = \frac{2 \times \text{precision} \times \text{recall}}{\text{precision} + \text{recall}}$$

$$\text{accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{FN} + \text{TN} + \text{FP}}$$

Where: TP is True Positive
TN is True Negative
FP is False Positive
FN is False Negative

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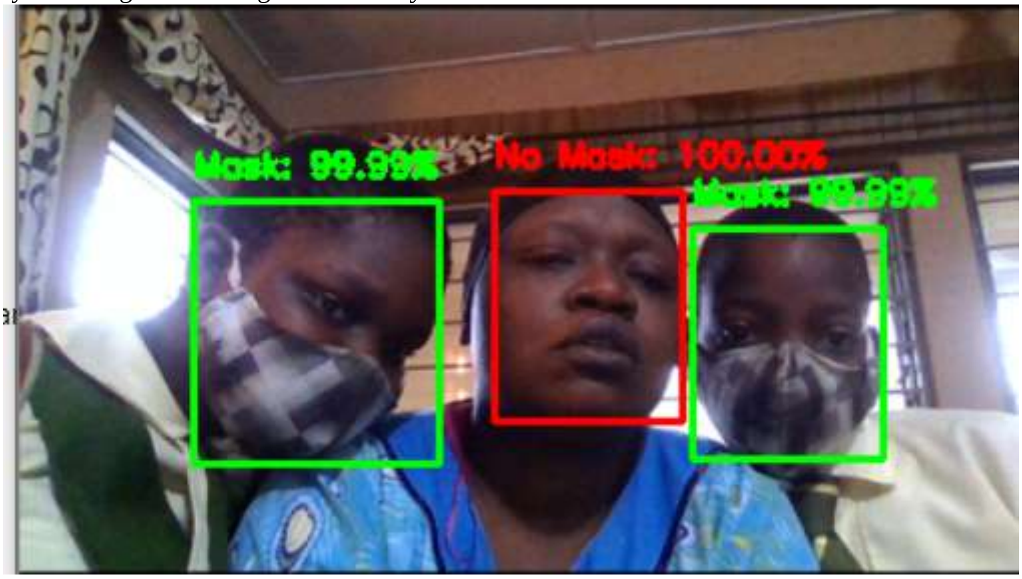
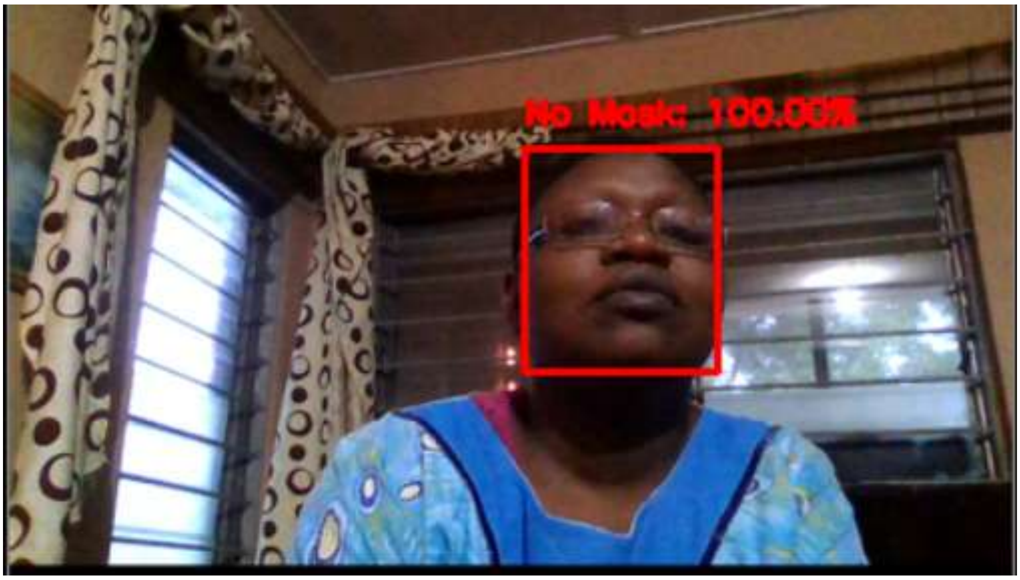
The model on images containing one and more faces. It was also implemented on videos and live video streams by removing and wearing masks one by one. Some screenshots of the results are shown below:





V. CONCLUSION

With further improvements these types of models could be integrated with CCTV cameras to detect and identify people without masks as well as to a Live Video Camera. This project can also be integrated with embedded systems for application in airports, railway stations, offices, schools, and public places to ensure that public safety guidelines are followed.

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