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On Campus Deployment of Face Mask Detection and Defaulter Identification

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Abstract:- The continuous spread of Corona virus has led to sustained increase in the mortality rate of many countries across the globe. WHO has made the use of masks mandatory in largely crowded areas which have reported Covid-19 cases. In order to curb the spread of virus and prevent cases, the detection of violators is highly desirable. We propose a model which highlights the use of deep learning approaches to identify people who do not wear mask. As most of the institutions, companies, industries, malls, hospitals, etc. have to start operating with few relaxations before this pandemic is completely erased, integrating face mask detection system with the existing surveillance systems at entry and exit points is highly recommended. The face mask detection model is built upon the MobileNetV2 architecture and detects face masks along with the percentage accuracy of wearing the mask properly in crowded scenes, both in images and real time streams. As the next step, the fresh concept of introducing facial identification of defaulters acts as a measure to keep the authorities informed of the people who are violating Covid-19 policies. Under the current Covid-19 lockdown time such system is definitely important to prevent the spread in many use cases. Airports, Hospitals, Offices will be some places which will benefit out of this system.

Keywords:- *Mask Detection, Face Recognition, Database Connectivity, MobileNetV2, Computer Vision, COVID-19.*

I. INTRODUCTION

COVID-19 has changed our daily life and continues to do so. Things getting back to how there were seems like a distant vision but, we cannot put everything at halt. If public places like malls, airports, schools, offices, etc. have to open, certain precautionary measures will be followed. One of the very basic rules is compelling customers and/or visitors to wear face masks and the accompanying obligation to check for customer/visitor compliance. Even after restrictions and fines being imposed for not wearing a mask, people are still stepping out without one, or even if they wear it, their nose or mouth is often left uncovered. It would be strenuous to physically monitor every person to authenticate their access.

We live in the 21st century where almost everything is technology-driven. The Face Mask Detection system is built on the stems of technology like TensorFlow, OpenCV, and Computer Vision. Similar to metal detectors deployed at the entrances of malls, airports, etc., this software can be deployed in cctv cameras. We can automatically authenticate the entry access of a person by cctv camera feed by checking if the person is wearing mask correctly or not. This face mask detector can be deployed in any place where inflow of people is maximum on a daily basis. As further steps, the people not wearing masks can be identified by taking

II. RELATED WORK

The prevention or control of Covid-19 can be achieved with the intervention of Artificial intelligence as mentioned in [1].

As per WHO, use of masks is made mandatory in communities, largely crowded areas. Owing to this protocol, a lot of research has been initiated and completed on detecting face masks using different approaches. Out of all the proposed architectures, the use of pre trained CNNs has proven to be best for the required purpose as mentioned in [2], [3] and [8].

Face mask detection has widely been implemented after the rise of the pandemic, but there has been no progress on how to manage people who are not wearing masks. An IOT based implementation of identification of defaulters has been done in [6]. However, the cost of hardware is unavoidable. We aim to provide a cost effective and easy to implement solution by eliminating hardware and introducing the concept of face identity recognition and database management.

Fig 1. Mask Detection

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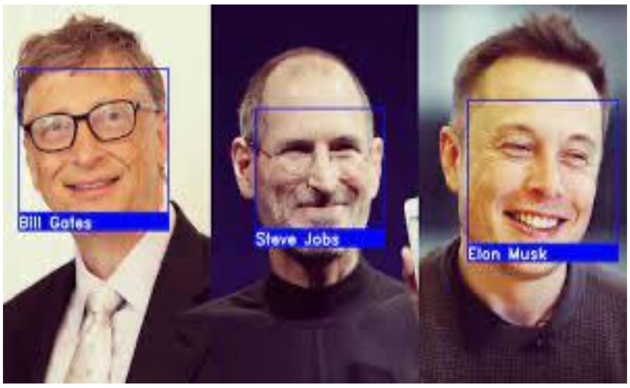

Fig 2: Facial Recognition

III. DESIGN DESCRIPTION

The model is designed for two purposes: detecting masks on the faces of people in the real time video stream and identifying the people who aren't wearing face masks with their name and id.

A. Face mask detection

This step aims at classifying whether a person is wearing, not wearing or incorrectly wearing(nose uncovered) the mask by determining the percentage accuracy of the correct way to wear a mask. This is achieved by taking input from images and real time streaming videos. The proposed system considers a dataset of size 1300 images

The classification of the images into two classes i.e., "with mask" and "without mask" is done by training the model in 2 phases. In phase 1, the mask dataset is loaded into the system. The face mask classifier model is developed using MobileNetV2 which is a Convolutional Neural Networks based method developed by Google known to be state of the art in Computer Vision related applications. Post training, the face mask classifier is serialized to disk. In phase 2, the face mask classifier model generated previously is loaded and applied to every facial image to extract the Region of Interest (ROI). The faces to be detected are taken from images and real time videos. The classifier then detects the presence of mask with confidence.

B. Identification of the defaulter

The violators i.e., people not wearing masks are detected from the previous step. The next step is to identify them which has been done face recognition library provided by python. It is assumed that the organization using the proposed model has maintained a database containing images and personal of people concerned with the organization. The unique id of the person is retrieved from the data and the administrator is informed regarding the same for further action to be taken.

The details of such defaulters are kept aside for future reference. The database from which the unique id is retrieved from generally consists other details such as name, department/post/role in organization, email, contact number, etc. of the members which may vary according to the organization. Warnings are given to people who are identified repeatedly according to the defaulter data and once the limit exceeds, actions can be taken.

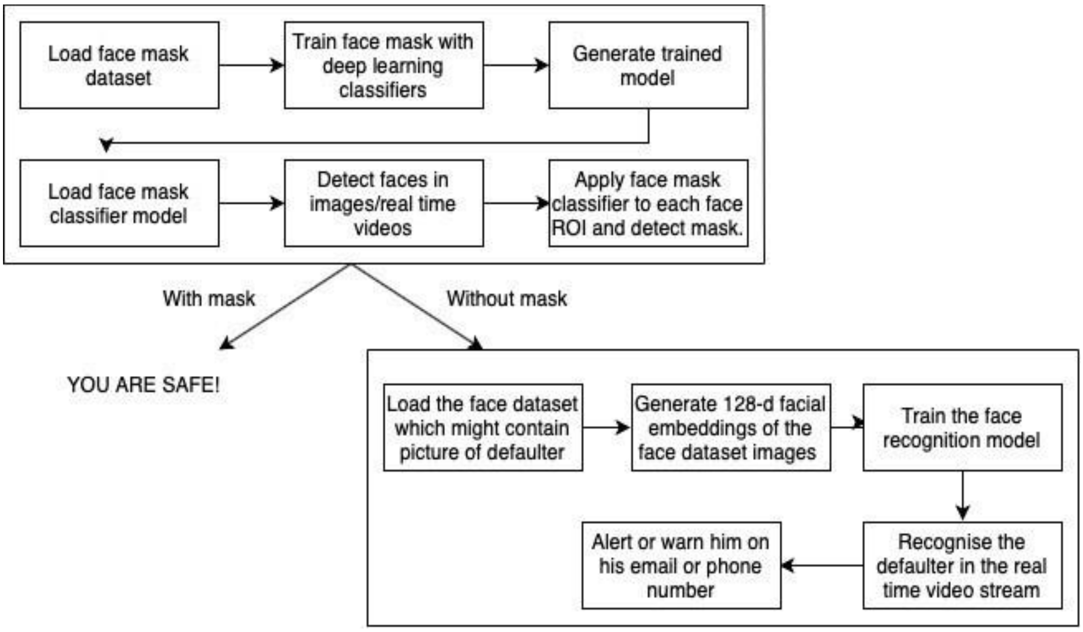

Fig 3: Proposed design

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IV. IMPLEMENTATION

A. Dataset

To create this dataset, *normal images of faces have been taken*. Then, a *custom computer vision Python script* has been written to add face masks to these images, thereby creating an *artificial* yet real-world applicable dataset. To make this process convenient, we apply facial landmarks to the problem. Facial landmarks allow us to automatically infer the location of facial structures, including eyes, eyebrows, nose, mouth, jawline, etc.

We start with the image of a person not wearing mask and start building upon it to generate our synthetic mask dataset. We apply face detection to compute the bounding box location of the face in the image. Once we know *where* in the image the face is, the Region of Interest (ROI) is extracted. To localize the eyes, nose, mouth, etc., we perform facial landmark detection which is robust to rigid and non-rigid facial deformations owing to natural movements, poses and expressions.

An image of a mask (with a transparent background) is taken. This mask will be *automatically* applied to the face according to the facial landmarks extracted along the nose and chin previously which compute and specify an exact fit for the mask. The mask is then resized and rotated, placing it on the face: The process is repeated for all input images, thereby creating the artificial face mask dataset.

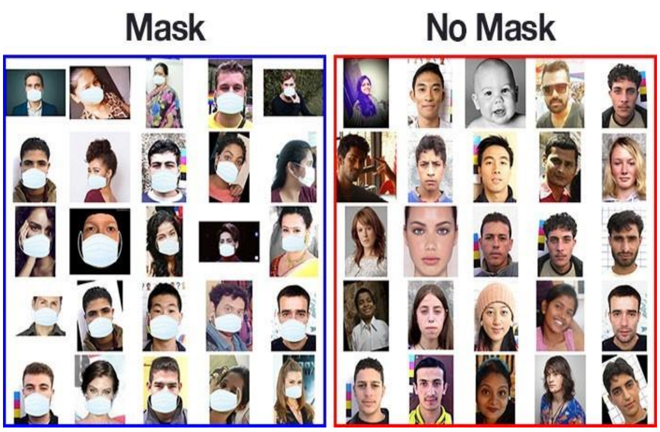

Fig 4: Face mask dataset containing "with mask" and "without mask" images

The idea behind generating this custom face mask dataset is that if we use a set of images to create an artificial dataset of people wearing masks, we *cannot* "re-use" the images *without masks* in our training set, we still need to gather non-face mask images that were *not* used in the artificial generation process! And if we include the original images used to generate face mask samples as non-face mask samples, the model will become heavily biased and fail to generalize well.

B. Data pre-processing and augmentation

Pre-processing steps include resizing to *224×224* pixels, conversion to array format, and scaling the pixel intensities in the input image to the range *[-1, 1]*.

The next step is to one-hot encode our class labels. Now, each element of our labels array consists of an array in which only one index is "hot i.e., 1.

Augmentation is performed using Keras Image Data Generator class which applies on-the-fly mutations to our images like rotation, zoom, shear, shift, and flip parameters are established

C. Mask detection

The pre trained CNN architecture used to train the face mask classifier is MobileNetV2 as it seeks to perform well on mobile devices. As we plan on using the proposed model in cctv and vigilance cameras, using this architecture is appropriate. It is necessary to fine tune any pretrained CNN in order for it to perform well on our custom dataset.

The MobileNetV2 architecture has two types of blocks One is residual block with stride of 1 and another is with stride of 2 for downsizing. There are 3 layers for each of the two blocks. The **first layer** is **1×1 convolution with ReLU6.** The **second layer** is the **depth wise convolution**. The **third layer** is another **1×1 convolution but without any nonlinearity.** It is claimed that if REL is used again, the deep networks only have the power of a linear classifier on the nonzero volume part of the output domain.

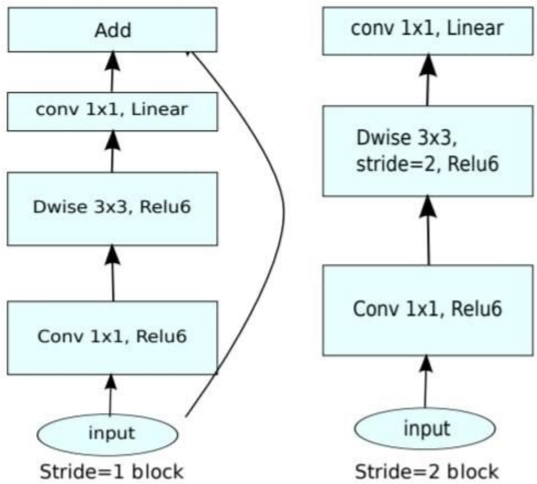

Fig 5: MobileNetV2 architecture

For fine tuning, the MobileNetV2 is loaded with pretrained ImageNet weights, leaving off head of network. We then construct a new FC head and append it to the base in place of the old head. The base layers of the network freeze to ensure they are not updated during the process of backpropagation, whereas the head layer weights *will* be tuned.

We finally compile our model with the Adam optimizer, a learning rate decay schedule and the binary cross entropy loss and make predictions on test data.

D. Real time detection

OpenCV is used to detect faces in images and real time video streams. The face mask classifier performs classification on these images. A bounding box is generated around the face in the image or video along with the class label displayed in the color assigned to it. We have two classes, with mask denoted in green and without mask denoted in red.

E. Person identification

The identification of people without masks is done using python's face recognition library. It is the world's simplest face recognition library and yet state of the art. It employs dlib, a modern C++ tool kit that consists of several machine learning algorithms.

We start with reading all images already present in our corpus and convert them into feature vectors for our algorithm to be able to interpret. We then loop over these feature vectors and compare the feature vectors of each loaded image to those of the image to be recognized. If we get a perfect match, we print the corresponding unique id of the image which is present in the organization data.

F. Database connectivity

After person identification, the unique id retrieved is sent to be searched in a database (we have used mongo dB). A NoSQL database is preferred as the member data of an organization can be huge and widespread. We use PyMongo, the python driver for mongo DB. Once the connection is established, we perform the usual search operations and obtain the personal details associated with the id.

V. PERFORMANCE

After training the model, validation is performed to test the generalizability of our model to unrecognized input data. Training is done for 20 epochs after which the loss and the accuracy of training and validation is plotted against the number of epochs. The plot is shown in Fig 6. As it can be observed, the validation accuracy is greater than training accuracy which proves our model is robust and can be used for new, unseen data. A significant observation is in the case of loss where the validation loss seems to be lesser than training loss, indicating the problem of overfitting may arise.

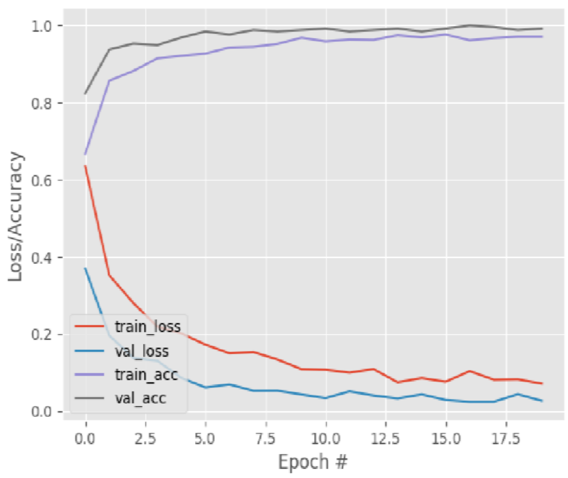

Fig 6: Training loss/accuracy

VI. RESULTS

After training and testing, the proposed model shows promising results. The confusion matrix generated post training is shown in Fig 7.

The reported accuracy of the model is 93%. i.e., out of every 100 images with masks, 93 images are reported correctly. The precision is 99% i.e., out of 100 images predicted to be with masks, 99 are correctly reported.

	precision	recall	f1-score	support
with_mask	0.99	0.86	0.92	383
without_mask	0.88	0.99	0.93	384
accuracy			0.93	767
macro avg	0.93	0.93	0.93	767
weighted avg	0.93	0.93	0.93	767

Fig 7: Confusion matrix

VII. FUTURE SCOPE

We believe that through this proposed idea, we have been able to achieve our goal of preventing the spread of Covid-19 up to some extent. Although, there are a number of aspects which can be looked into to improve the reliability and robustness of this system. As future scope, we propose the following.

1. The model detects faces in real time video streams but might not be efficient in detecting face masks for people
2. The model fails to recognize the type of face cover i.e., handkerchief, cloth mask, surgical mask, N-95, etc worn by the person which ultimately, is an important factor to prevent entry of virus into the body.
3. The face identification phase requires images of people beforehand which might be a tedious task in case of huge organizations.
4. The face recognition library being used for the identification of defaulters is subject to ethical risk while commercialization.
5. The database maintenance requires skilled professionals and proper infrastructure which may not pe feasible for small scale organizations.

VIII. CONCLUSION

In this paper, we present a novel approach to prevent the spread of COVID-19 with minimum manpower and maximum monitoring. For any closed organization, the members are limited and well acquainted due to which it becomes very convenient to have a system like this to supervise them in the best of their interest. If this system is put to proper use, manpower being deployed for security and surveillance on ground will be automatically reduced thus, protecting such officials from chances of being infected as they are on the front always. As the system does not involve hardware, effective cost cutting can be done. The proposed model is light weight and robust and can be deployed in cctv cameras of institutions. We might not be able to point out each defaulter but up to some extent, the flow of Covid 19 can be controlled with discipline and vigilance.

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REFERENCES

[1]. Raju Vaishya, Mohd Javaid, Abid Haleem; "Artificial Intelligence (AI) applications for COVID-19 pandemic, Diabetes & Metabolic Syndrome", Clinical Research & Reviews Volume 14, Issue 4, July– August 2020, Pages 337-339

[2]. Samuel Ady Sanjaya, Suryo Adi Rakhmawan;" Face Mask Detection Using MobileNetV2 in The Era of COVID- 19 Pandemic", 2020 International Conference on Data Analytics for Business and Industry: Way Towards a Sustainable Economy(ICDABI)

[3]. Preeti Nagrath, Rachna Jain, Agam Madan, Rohan Arora, Piyush Kataria, Jude Hemanth," SSDMNV2: A real time DNN-based face mask detection system using single shot multibox detector and MobileNetV2", Sustainable Cities and Society, Volume 66, March 2021, 102692

[4]. Brandon Amos, Bartosz Ludwiczuk,† Mahadev Satyanarayanan, "OpenFace: A general-purpose face recognition library with mobile applications", eports - archive.adm.cs.cmu.ed

[5]. Nataliya Bokyo, Oleg Basystiuk, Nataliya Shakhovska, " Performance Evaluation and Comparison of Software for Face Recognition, Based on Dlib and OpenCV Library" 2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP)

[6]. Anirudh Lodh; Utkarsh Saxena; Ajmal khan; Anand Motwani; L Shakkeera; Vali Y Sharmasth, "Prototype for Integration of Face Mask Detection and Person Identification Model – COVID-19", 2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA)

[7]. Sammy V. Militante; Nanette V. Dionisio,"Real-Time Facemask Recognition with Alarm System using Deep Learning", 2020 11th IEEE Control and System Graduate Research Colloquium (ICSGRC)

[8]. Mark Sandler, Andrew Howard, Menglong Zhu, Andrey Zhmoginov, Lia,ng-Chieh Chen, "MobileNetV2: Inverted Residuals and Linear Bottlenecks", IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2018, pp. 4510-4520

[9]. Jafri, Rabia, Arabnia, Hamid R., " A Survey of Face Recognition Techniques", Journal of Information Processing Systems