Face Mask Detection Using Image Processing

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Abstract :-

Amidst the during pandemic covid-19, it is crucial to abide by the strict regulations set by the authorities to ensure the safety of individuals within the community. However, it may not always be feasible to have official personnel monitor compliance with these rules at all times. To address this issue, a face mask detection project can be developed, which would allow us to determine whether an individual is wearing a mask or not. Implementing such a project could prove to be a valuable contribution towards maintaining societal well-being during these unprecedented times of lockdown and stringent safety protocols.

In light of the current pandemic situation, implementing a project that processes images of a specific area or region to track people on streets or roads and determine if they are wearing masks could be a highly beneficial undertaking. By leveraging image processing algorithms and advanced deep learning techniques, the project can accurately identify whether individuals are adhering to the mask-wearing protocols. To accomplish this, the Kaggle dataset for face mask detection could be employed as a solid starting point to train the model and achieve an impressive level of accuracy in the image analysis.

To tackle this issue effectively, utilizing transfer learning models like VGG-16, face-net, RESNET-50, Mobile Net and similar architectures, along with programming tools such as Python, OpenCV, and TensorFlow, would be an optimal approach. A good starting point would be to refer to my previous article on intelligent face lock systems, which covers the construction of advanced face recognition systems.

➢ Keywords:— Covid-19, Machine Learning, NumPy, OpenCV, TensorFlow, Imutils, Face_mask_detector.

I. INTRODUCTION

Face Mask can be detected using Machine Learning Algorithm (Supervised), VGG-16, face-net, RESNET-50, Mobile Net etc.. Among all of them Machine Learning algorithm i.e., Supervised Learning algorithm along with tools such as Python, OpenCV, and TensorFlow is preferred for its better performance. The Data is collected and made it into dataset i.e., A set of data examples, that contain features important to solving the problem (face mask detection) and Image classification is a great challenge for detection of mask. For this purposes, the training is given where the Machine Learning algorithm (supervised learning algorithm) actually learns by showing it the data that has been collected and prepared. The model is prepared which represents a phenomenon that a Machine Learning algorithm has learnt. It learns this from the data it is shown during training. The model is the output you get after training an algorithm. The testing of model is a process where the prepared model is examined to check weather the model is performing well or not. Same algorithm is applied until we get best fit model for face mask detection. Model which is prepared performs face mask detection with red box for no mask and green boxes for mask along with percentages and sound system. If any one is not wearing mask , it detects and suggest to ware mask .

II. LITERATURE REVIEW

The field of Face Recognition algorithms has seen significant research, with several methods developed for detecting face masks in image datasets. These methods include Face Mask Detector, Multi-Stage CNN Architecture for Face Mask Detection, Real-time Face Mask Recognition with Alarm System using deep learning, and Face detection technique using Mobile Net CNN Architecture. While Face Mask Detector improves mask detection, it suffers from long data loading times in Google Colab Notebook. Multi-Stage CNN Architecture for Face Mask Detection can detect both masked and unmasked faces but is a time-consuming iterative process. Real-time Face Mask Recognition with Alarm System uses VGG-16 as its foundation network for face recognition, but its accuracy is lower than that of Multi-Stage CNN Architecture for Face Mask Detection. Despite the availability of several techniques for face mask detection, there is still a need to develop an efficient and fast technique.

In 2017 Rajeev Ranjan, Vishal M Patel et.al. [1] proposes a multi-task learning framework called HyperFace for simultaneous face detection, landmark localization, pose estimation, and gender recognition. The proposed framework is based on a deep convolutional neural network (CNN) architecture and is designed to leverage the shared representations across the different tasks to improve overall performance.The HyperFace architecture consists of two streams: a task-specific stream and a shared stream. The task-specific stream consists of multiple branches, each dedicated to a specific task (face detection, landmark localization, pose estimation, and gender recognition). Each branch has its own set of convolutional layers followed by fully connected layers that output task-specific predictions. The shared stream, on the other hand, consists of a set of convolutional layers that are shared across all tasks. This shared stream is designed to learn a shared representation of the face that can be used to improve the performance of all tasks.The authors train the HyperFace model using a multi-task loss function that combines the losses from all tasks. They also introduce a novel task-balanced sampling strategy to balance the contributions of each task during training. The proposed method is evaluated on several face benchmark datasets and is shown to achieve state-of-the-art performance on all tasks compared to other existing methods.Overall, the HyperFace framework provides a unified and efficient approach for simultaneously performing multiple face analysis tasks with improved accuracy and speed.

Militante and Dionisio et.al. [2] from 2020 proposed a real-time face mask recognition system using machine learning. The system was designed to detect whether a person is wearing a face mask or not, and an alarm is triggered if the person is not wearing a mask. The system uses a convolutional neural network (CNN) with a MobileNetV2 architecture for the mask recognition task. The authors used transfer learning and fine-tuned the pre-trained model on a dataset of images containing people wearing and not wearing masks. The system was tested on a Raspberry Pi 4 and achieved a recognition accuracy of 97.5%.

In 2001, Viola and Jones [3] proposed a method for rapid object detection using a boosted cascade of simple features. The method uses Haar-like features and AdaBoost algorithm to efficiently train classifiers that can detect objects in an image. The cascaded classifier is constructed by chaining multiple classifiers, each of which has different levels of complexity and can reject non-object regions early on in the process. This helps to speed up the detection process and reduce the number of false positives. The method has been widely used for face detection, but can be applied to other object detection tasks as well.

In 2021, Loey et al. [4] proposed a machine learning model for medical mask detection to fight against COVID-19. The model was based on YOLO-V2 (You Only Look Once) with ResNet-50, which is a popular object detection algorithm. The proposed model was trained on a large dataset of masked and unmasked faces to detect whether a person is wearing a mask or not. The study reported an accuracy of 98.76%, which shows the effectiveness of the proposed model in detecting medical masks. The proposed model can be used in various applications, such as in public areas, hospitals, and airports, to ensure that people are following mask-wearing guidelines to reduce the spread of COVID-19.

In 2015, Li et al. [5] propose a cascade of convolutional neural networks (CNNs) for face detection, called the Convolutional Neural Network Cascade (CNCC). The CNCC consists of a series of CNNs trained with different scales and resolutions, which allows for accurate detection of faces at various sizes and orientations. The authors evaluate the proposed method on several benchmark datasets and demonstrate its effectiveness in achieving state-of-the-art performance in face detection accuracy while maintaining fast computation time. They also show that the CNCC outperforms previous methods that use handcrafted features, such as the Viola-Jones algorithm. Overall, the paper presents a promising approach for face detection using deep learning techniques.

In 2015, Yang et al.[6] proposed a deep learning approach for face detection that goes beyond traditional methods that rely on hand-crafted features. The authors proposed a facial-part-based approach in which the face is represented as a set of facial parts, and each part is detected separately using a convolutional neural network (CNN). The proposed method uses a single CNN for detecting all facial parts, with each part represented by a set of anchor boxes. The anchors are generated by clustering the facial part annotations in a training set and then using k-means clustering to obtain anchor boxes for each part. The resulting facial-part-based detector is shown to outperform traditional methods on the popular benchmark datasets FDDB and WIDER FACE. The proposed approach also achieves state-of-the-art performance on the AFLW dataset, which contains faces with large pose variations.

Nguyen et.al. [7] from 2020 proposed a fast object detection framework based on a MobileNetV2 architecture and an enhanced feature pyramid. The proposed framework aims to improve the accuracy and speed of object detection in images. The proposed framework uses a MobileNetV2 architecture as the backbone network and adds an enhanced feature pyramid network (EFPN) to improve the feature representation of the backbone network. The EFPN generates multi-scale feature maps that are used for object detection. The proposed framework was tested on the COCO dataset and achieved state-of-the-art accuracy and speed results.

III. PROPOSED METHODOLOGY

The proposed system can be summarized in Five stages. First stage is data collection in which the images of all faces with and without mask are collected. This data is collected from google are Kaggle. In the second stage of the face mask detection project, the data preparation process is undertaken, which involves formatting and engineering the data into an optimal format. This includes extracting important features, performing dimensionality reduction, and visualizing the dataset. However, for face mask detection, only a few datasets are available, and most of them are either artificially created or contain noise and incorrect labels. Therefore, to address this issue, we created a practical dataset by gathering images from various sources such as MAFA, RMFD, CelebA, and the internet. We manually inspected and cleaned the dataset, resulting in a final dataset of 4000 images labeled as "with_mask" and "without_mask." The distribution of the dataset is shown in Figure 1 and 2, which yielded successful results at the end.

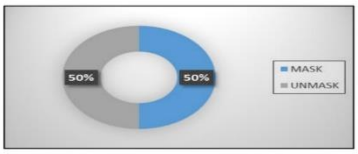

Fig.1 Dataset Visualization

Fig.2 Data set of mask and no mask

In the third stage of the face mask detection process, the model training begins with the use of an appropriate dataset to predict whether an individual is wearing a mask or not in real-time. It is crucial to have a precise face detector model to detect faces accurately, so that it can classify masked and unmasked faces correctly. For this task, an OpenCV's Single Shot Multibox Detector with ResNet-10 as its backbone is used for real-time detection of faces. The classifier utilizes the MobileNetV2 pre-trained model to make predictions. The workflow of the proposed model is shown in Figure 3.

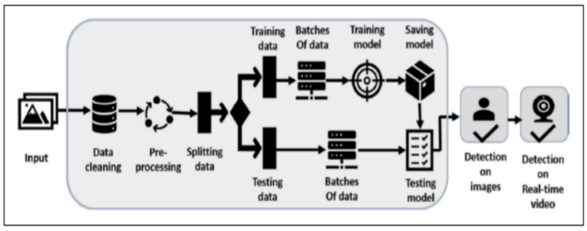

Fig.3 Working of the system

The flow chart of the proposed system is given below figure 4.

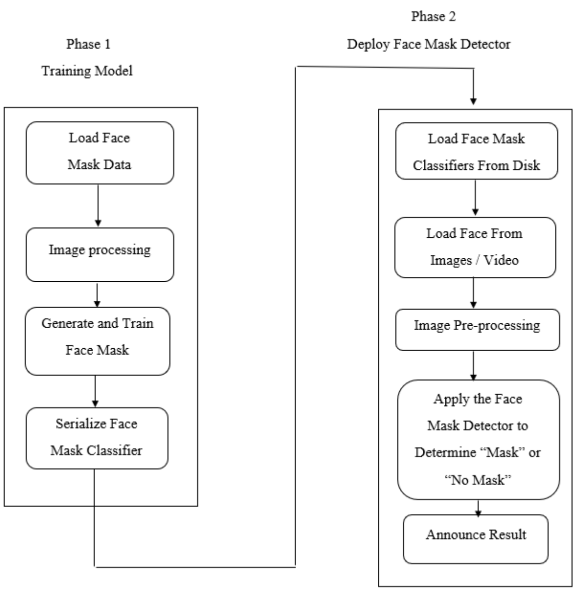

Fig. 4. Flowchart of the proposed system

The final two stages includes Evaluation and Tuning where the evolution is Test the model to see how well it performs and Tuning is to Fine tune the model to maximise it's performance.

IV. RESULTS AND DISCUSSION

In this work, we have developed a deep learning model for face mask detection using Python, Keras, and OpenCV. We developed the face mask detector model for detecting whether person is wearing a mask or not. We have trained the model using Keras with network architecture. Training the model is the first part of this project and testing using webcam using OpenCV is the second part and supervised learning algorithm is used which classifies people with mask with green box and without mask with red box indicating with percentage of masks . If any people is not wearing mask it suggests to wear mask by the message please wear mask.

We used a laptop that is customized with an AMD Ryzen 5 3550H processor and has 8GB of RAM to conduct experimental trials. For the development and implementation of the experimental trials, we used the command prompt with a Python 3.8.5 kernel. The percentages given to different classifications of masks are shown in the following table:

	precision	recall	f1-score	support
with mask	0.95	0.99	0.97	500
without mask	0.99	0.95	0.97	500
accuracy			**0.97**	1000
macro avg	0.97	0.97	0.97	1000
weighted avg	0.97	0.97	0.97	1000

Fig. 5. Percentage values for different classification of mask

The outputs of the model is shown in the given below figures 6 :

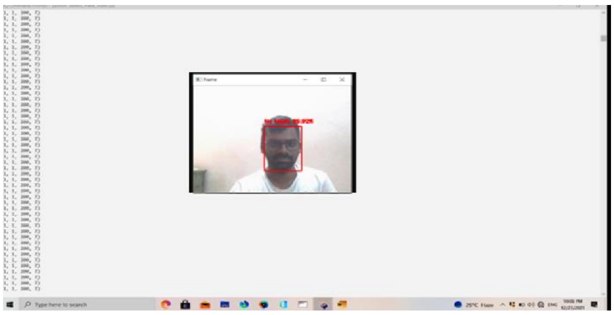

Fig 6 (a) Detecting the person face and indicating with red rectangle box that he is not wearing mask along with mask percentage.

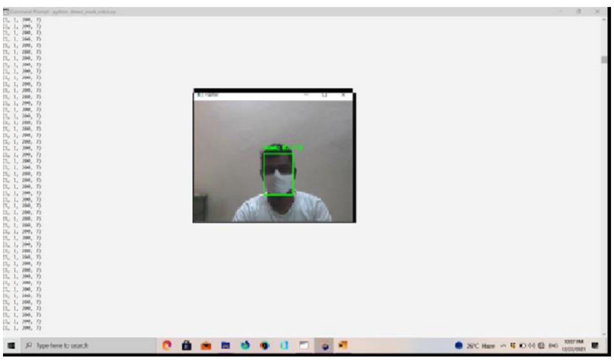

Fig 6 (b) Detecting the person face and indicating with green rectangle box that he is wearing mask along with mask percentage.

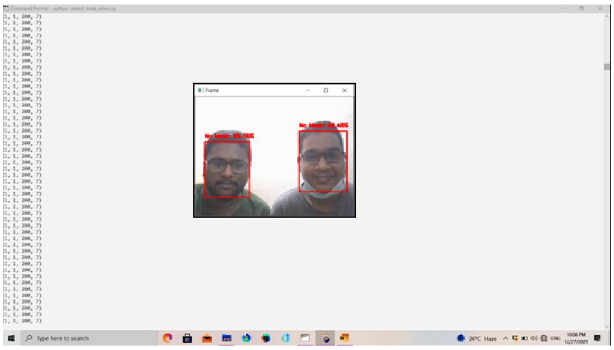

Fig 6 (c) Detecting the multiple faces and indicating with red rectangle box that they are not wearing mask along with mask percentage.

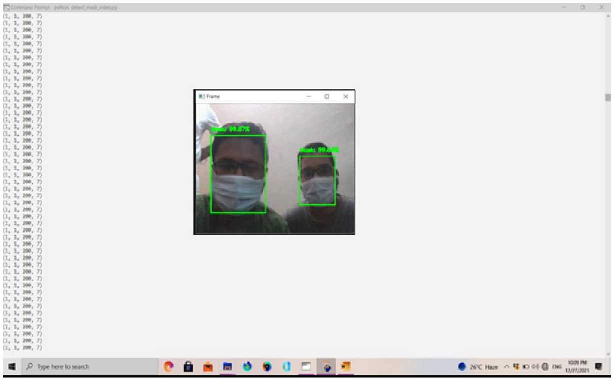

Fig 6 (d) Detecting the multiple faces and indicating with green rectangle box that they are wearing mask along with mask percentage.

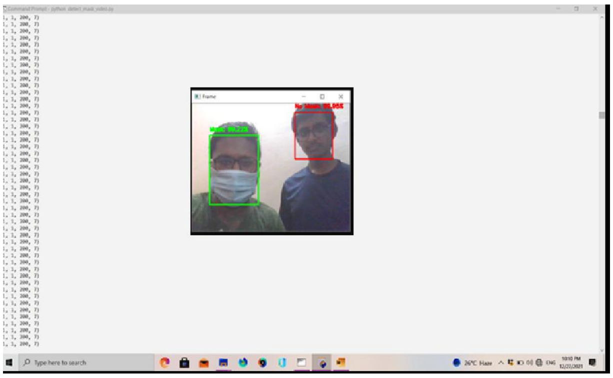

Fig 6 (e) . Detecting the multiple faces and classifying that who is wearing mask and who are not with green and red color rectangular boxes along with mask percentage.

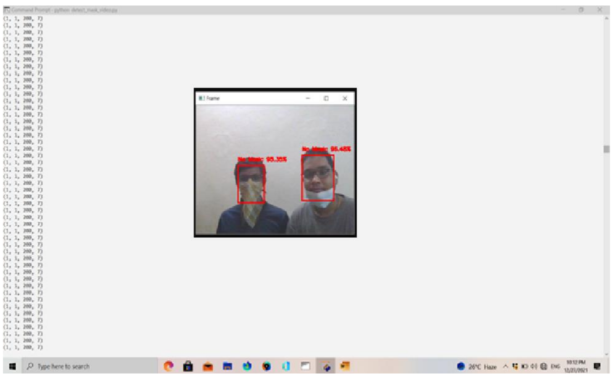

Fig 6(f) Detecting the multiple faces and its is indicating with rectangular red boxes for improper mask wearing along with mask percentage. It is specifying even person wearing cloth that to wear a original mask.

V. CONCLUSION

By developing a Face Mask Detection model using OpenCV and Machine Learning with an image classifier, we were able to address the limitations of previous work and achieve better results. The model's accuracy has improved significantly as a result of successfully addressing issues with incorrect predictions. This automated system can effectively track individuals in public places where crowd monitoring is required. Additionally, the practical dataset created can be used for the development of more advanced models, including those for thermal screening and facial recognition.

VI. REFERENCES

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