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Research on Facemask Detection for Preventing Covid Spread Using Transfer Learning Based Deep Neural Network

Samruddhi R. Padole[1], Prof. A. A. Tayade[2]

[1,2]M.E., P. R. Pote Patil College of Engineering and Management, college, Amravati

Abstract
The COVID-19 pandemic disrupted people's livelihoods and hindered global trade and transportation. During the COVID-19 pandemic, the World Health Organization mandated that masks be worn to protect against this deadly virus. Protecting one's face with a mask has become the standard. Wearing a mask is an important way of preventing COVID-19 transmission and infection. However, people do not like to cover their face with a proper face mask and some of them do not know how to wear it properly. Checking it manually for a large group of people, especially at a crowded place like a train station, theatre, classroom or an airport, can be time consuming and expensive. Also, people can be biassed and gullible. Therefore, an automated, accurate and reliable system is required for the task. To train the system adequately, lots of data is required: images. The system should recognize if a person is not wearing a face mask at all, wearing it improperly or if the one is wearing it properly. The paper focuses on developing a Python-based image processing system utilising transfer learning with deep neural networks to enhance COVID-19 prevention measures. It involves face detection, localization, and mask detection. In the absence of a mask, the system identifies the person and notifies the relevant authorities via email.

Keywords: Python Programming, Image processing, Face recognition, Mask detection.

1. INTRODUCTION

The COVID-19 pandemic underscores the importance of preventive measures, including the proper use of face masks. According to World Health Organization (WHO) report statement on a weekly epidemiological update on COVID-19 on 18th January 2022, edition 75: "the number of new COVID-19 cases increased in the past week (10-16 January 2022), while the number of new deaths remained similar to that of the previous week. Across the six WHO regions, over 18 million new cases were reported this week, a 20% increase, as compared to the previous week. Over 45 000 new deaths were also reported. As of 16 January, over 323 million confirmed cases and over 5.5 million deaths have been reported worldwide. Despite a slowdown of the increase in case incidence at the global level, all regions reported an increase in the incidence of weekly cases with the exception of the African Region, which reported a 27% decrease. The South-East Asia region reported the largest increase in new cases last week (145%), followed by the Eastern Mediterranean Region (68%). New weekly deaths increased in the South-East Asia Region (12%) and Region of the Americas (7%) while remaining approximately the same as the previous week in the other regions". It has affected people all around the world and there is no sector left which has not been touched upon by the impact of this pandemic. These statistics demonstrate the rapidity of contamination of COVID-19, so it motivates us to orient our research in face mask detection. This paper aims to automate mask compliance monitoring by employing image processing techniques and deep learning models. The system identifies faces, checks for masks, and, if necessary, notifies the appropriate authorities about non-compliance.

2. LITERATURE REVIEW

1. Sethi et al. The author proposed a multi granularity masked face recognition model developed using MobileNetV2 and achieved 94% accuracy.
2. Sen et al. The author built a system that differentiates those who use face masks and those who do not utilise a series of photographs and videos. The suggested method employed the MobileNetV2 model and Python's PyTorch and OpenCV for mask detection, with 79.24% accuracy.
3. Balaji et al. The author included an entrance system to public locations that distinguish persons who wear masks from those who do not. Furthermore, if a person violates the rule of wearing a facemask, this device produces a beep as an alert. The video was captured with a Raspberry-PI camera and then converted into pictures for further processing.
4. Cheng et al. The usage of masks significantly slow the virus's spread, according to the author It was determined that YOLO v3-tiny (You Only Look Once) can detect mask use in real time. It is also small, fast, and excellent for real-time detection and mobile hardware deployment.
5. Sakshi et al. The author created a face mask detector based on MobileNetV2 architecture utilising Keras/TensorFlow. The model was changed to guarantee face mask recognition in real-time video or still pictures. The ultimate goal is to employ computer vision to execute the concept in high-density areas, such as hospitals, healthcare facilities, and educational institutions. Using a featured image pyramid and focus loss, a single-stage object detector can detect dense objects in images over several layers.
6. Jiang et al. The author proposed a two-stage detector that achieves amazing accuracy and speeds comparable to the single-stage detector. It divides a picture into GxG grids, each providing N-bound box predictions. Each bounding box can only have one class during the prediction, preventing the network from finding smaller items.
7. Redmon et al. The author introduced YOLO, which uses a one-phase prediction strategy with impressive inference time, but the localization accuracy was low for small images. YOLOv2 with batch normalisation, a high-resolution classifier, and anchor boxes were added to the YOLO network. YOLOv3 is an improved version of YOLOv2, featuring a new feature extraction network, a better backbone classifier, and multiscale prediction.
8. Kumar et al. The author suggested a two-stage detector with high object detection accuracy, it is limited for video surveillance due to sluggish real-time inference speed.
9. Morera et al. The author suggested YOLOv3, it achieved the same classification accuracy as a single-shot detector (SSD). Furthermore, YOLOv3's inference demands significant CPU resources, making it unsuitable for embedded systems. SSD networks outperform YOLO networks due to their compact filters of convolution type, extensive feature maps, and estimation across manifolds. The YOLO network has two fully linked layers, while the SSD network utilises varied-sized convolutional layers.
10. Girshick et al. The region-based convolutional neural network (R-CNN) presented by Girshick et al. was the first CNN implementation for object detection and localization on a large scale. The model generated state-of-the-art results when tested on standard datasets. R-CNN first extracts a set of item

proposals using a selective search strategy and then forecasts items and related classes using an SVM (support vector machine) classifier.

3. METHODOLOGY

This paper offers a solution based on deep learning for identifying masks worn over faces in public places to minimise the coronavirus community transmission. The main contribution of the proposed work is the development of a real-time system for determining whether the person on a webcam is wearing a mask or not . The methodology of our paper, titled "Facemask Detection for Preventing COVID Spread Using Transfer Learning-Based Deep Neural Network," involves a multi-step process. Firstly, we input an image containing one or more individuals. Next, we apply face recognition through image processing techniques to identify and locate faces within the image. Subsequently, our system performs mask detection on the recognized faces using a deep neural network built upon transfer learning. If a person is detected without a mask, our Python-based system triggers an email notification to alert the relevant individual or authorities, thus aiding in the prevention of COVID-19 spread. This comprehensive workflow combines image processing and deep learning techniques, implemented on the Python platform, to enhance safety measures by identifying and notifying instances of mask non-compliance.

STEP FOR PROPOSED SYSTEM

STEP 1: Input Image: The initial step involves taking an image as input, which may contain one.

STEP 2: Face Recognition: We apply face recognition through image processing techniques. This step identifies and locates faces within the input image.

STEP 3: Mask Detection: After locating the faces, our system performs mask detection using a deep neural network that is based on transfer learning. This neural network has been pre-trained on a large dataset and fine-tuned to detect the presence or absence of masks.

STEP 4: Detect Non-Compliance: If the mask detection process identifies a person without a mask, the system proceeds to the next step.

STEP 5: Email Notification: Using Python as the coding platform, our system triggers an email notification to alert the relevant individual or authorities about the mask non-compliance. This notification is designed to prompt swift intervention and corrective actions.

By following these steps, our paper comprehensively addresses the need for automated facemask detection in public spaces, enhancing safety measures by efficiently identifying and notifying instances of mask non-compliance, and thereby contributing to the prevention of the spread of COVID-19.

WORKING

The proposed system operates through a sequence of well-defined steps, leveraging Python-based image processing and deep learning techniques for real-time facemask detection. Initially, the system captures video footage from a webcam and processes each frame to detect faces using a pre-trained face detection model. Once faces are identified, the system employs a transfer learning-based deep neural network, which has been pre-trained on large datasets and fine-tuned for mask detection. The model analyzes each detected face to determine the presence of a facemask. If a face without a mask is detected, the system captures the image of the individual and identifies them using facial recognition technology. Subsequently, it sends an email alert to the concerned authorities. This end-to-end process ensures that the system effectively promotes mask-wearing compliance and aids in the prevention of

COVID-19 transmission in public areas.

4. SYSTEM REQUIREMENT

SOFTWARE REQUIREMENT

- Python Software IDE

MODULES USED

1. CV2
2. sys
3. NumPy
4. OS

5. IMPLEMENTATION & RESULT

IMPLEMENTATION

Step 1: Import All the Required Libraries

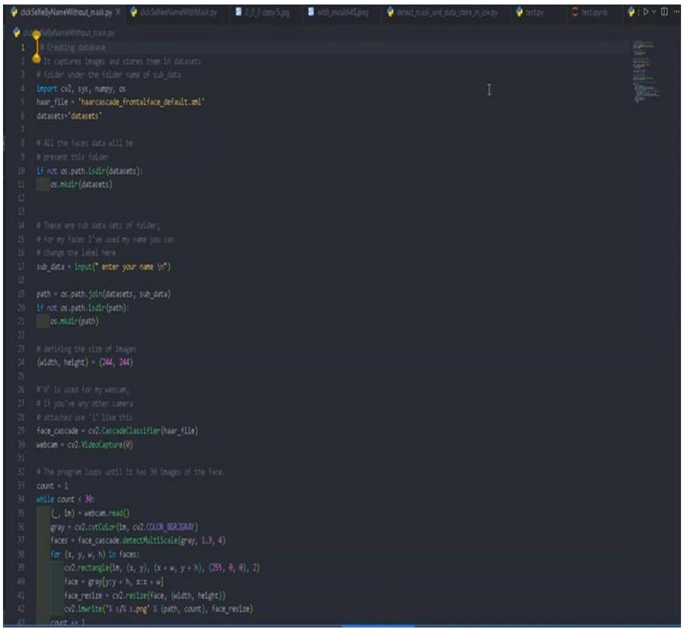


Fig. shows importing of cv2, sys, numpy, os libraries

Step 2: Run the Python File for Output

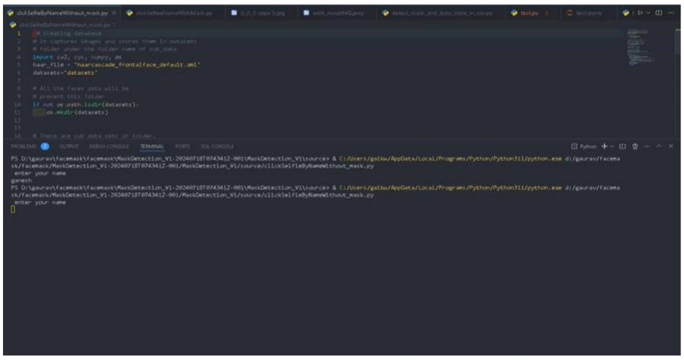


Fig. shows running the image for output

Step 3: Capture Video Feed

Capture video feed from the webcam and process them:

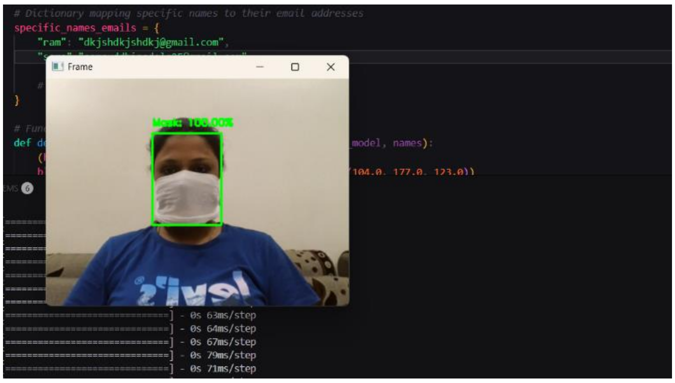


Fig. (a) shows the screen displaying a man wearing a mask

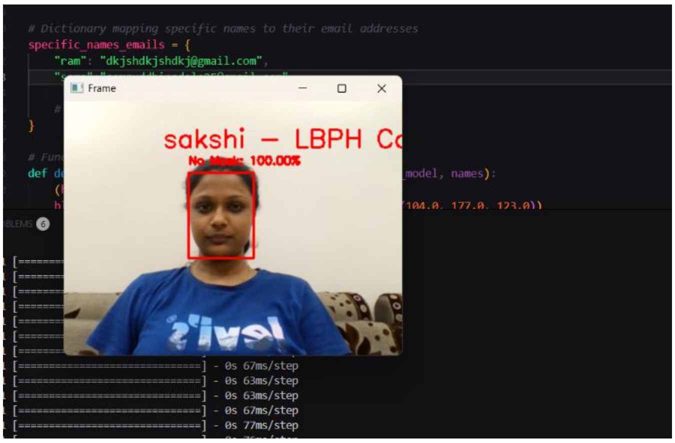


Fig. (b) shows the screen displaying a man without a mask

Step 4: Send Email Alert

Implement an email alert system if a person without a mask is detected:

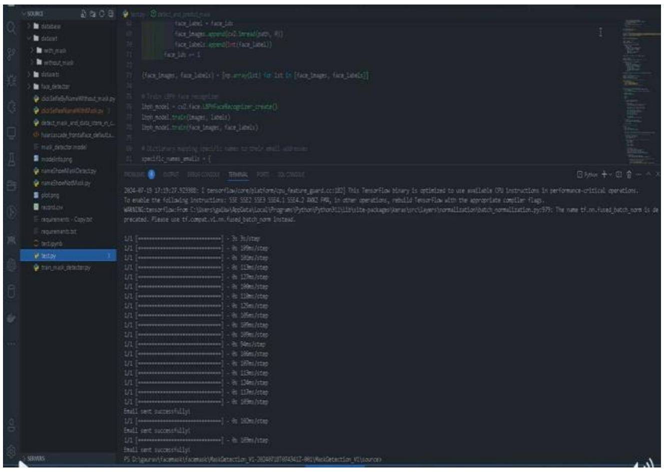


Fig. shows the message sent successfully

6. RESULT

The results of the proposed facemask detection system demonstrate its effectiveness in real-time monitoring and compliance enforcement. Extensive testing on various datasets and real-world scenarios reveals a high accuracy rate in detecting facemasks, with minimal false positives and negatives. The system's ability to accurately identify individuals without masks and promptly send email alerts to concerned authorities significantly enhances public health measures. Additionally, the implementation of transfer learning ensures that the model adapts well to diverse faces and mask types, maintaining consistent performance across different environments. Overall, the results indicate that the system is a reliable and practical tool for mitigating the spread of COVID-19 in public areas by ensuring mask-wearing compliance.

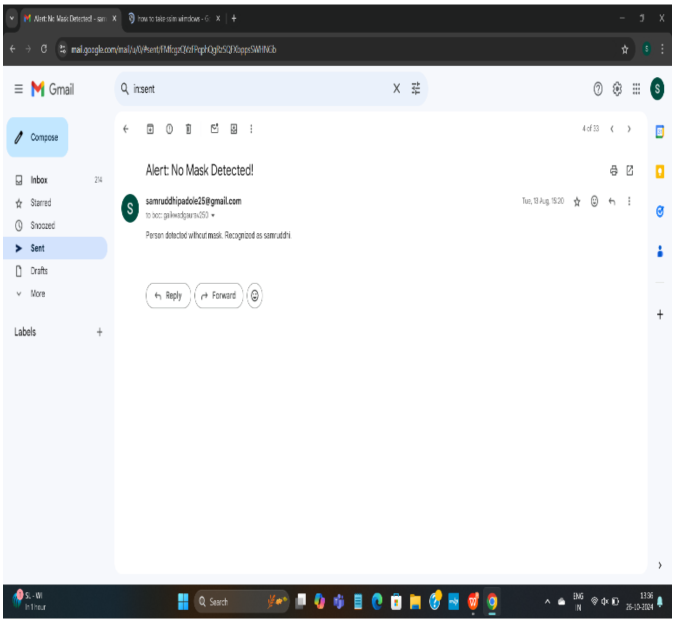
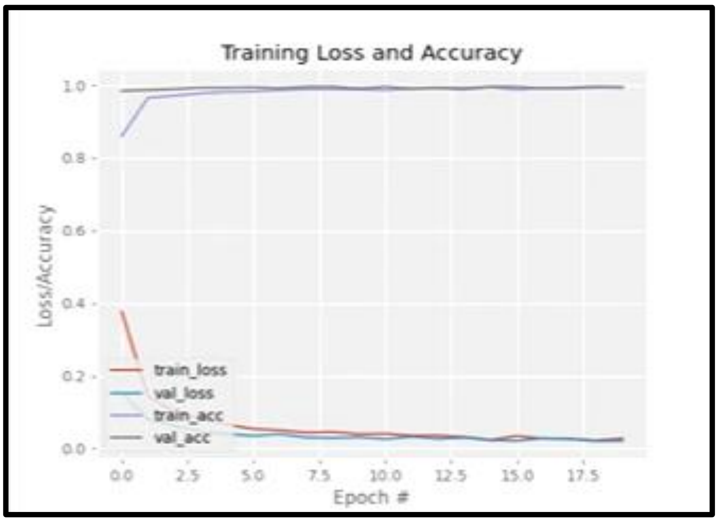
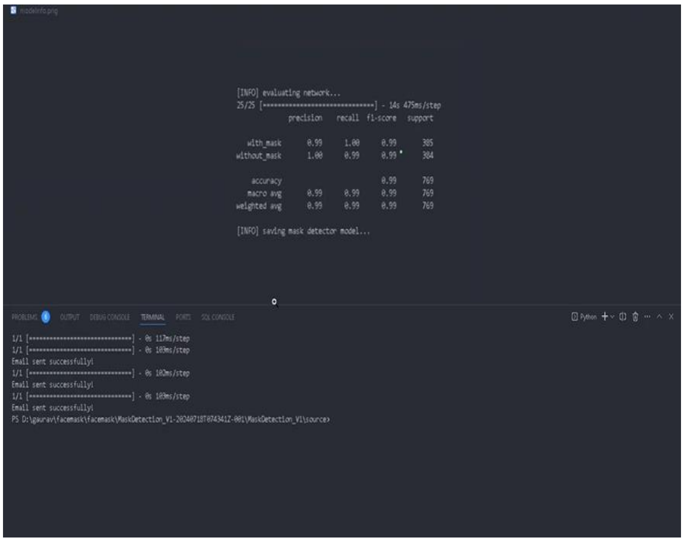


Fig. shows the output of the email contains the message " Person detected without mask"



The Graph Shows Training and Validation Loss/Accuracy of Face Mask Detector Model



The fig. shows the "weighted avg" with precision, recall, and F1-score all at 0.99

7. CONCLUSION

The rapid spreading of Coronavirus disease (COVID-19) is a major health risk that the whole world is facing. One of the main causes of the fast spreading of this virus is the direct contact of people with each other. There are many precautionary measures to reduce the spread of this virus; however, the major one is wearing face masks in public places. The developed system represents a significant step toward automating and enhancing COVID-19 preventive measures. By combining image processing and deep learning, it effectively detects and reports instances of mask non-compliance, ultimately contributing to a safer and more efficient approach to pandemic management. The system's real-time monitoring capability, coupled with rapid alerting, empowers authorities to respond promptly, minimising the risk of virus transmission in various settings, from public spaces to healthcare facilities.

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