Face Mask Recognition System Using Conventional Neural Networks

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Abstract: - Coronavirus plague has quickly disturbed our everyday lives influencing the worldwide exchange and developments. Wearing a facial covering to safeguard one's face has turned into the new typical. Sooner rather than later, numerous public specialist organizations will anticipate that the clients should wear covers properly to participate in their administrations. Subsequently, facial covering recognition has turned into a basic obligation to help overall human progress. This paper gives a straightforward method for accomplishing this goal using some key AI apparatuses such as TensorFlow, Keras, OpenCV and Scikit-Learn. The recommended procedure effectively perceives the face in the picture or video and afterward decides if it has a cover on it. As an observation work entertainer, it can likewise perceive a face along with a cover moving as well as in a video. The method accomplishes astounding exactness. We examine ideal boundary values for the Convolutional Brain Organization model (CNN) to distinguish the presence of covers precisely without producing over-fitting. The greatest accuracy is 96.84% measured using Proposed Deep Learning Method.

Keywords---Deep Learning, TensorFlow, Keras, OpenCV

I. INTRODUCTION

The SARS-CoV-2 virus is the source of COVID-19, sometimes referred to as the coronavirus, which is a highly infectious respiratory disease. It was initially discovered in Wuhan, China, in December 2019, and since then, it has spread around the world, causing a pandemic. When an infected person coughs, sneezes, or speaks, the virus mostly spreads by respiratory droplets. It can also be transferred by touching surfaces that have been contaminated with the virus. Wearing face masks is one of the most important things you can do to stop the COVID-19 virus from spreading. By acting as a barrier, face masks lessen the number of respiratory droplets that are transferred from the wearer to other people and vice versa.

The danger of getting the virus and transmitting it can be considerably reduced by using face masks correctly and consistently in addition to other preventative measures like hand cleanliness and social distance. The core functionality of face mask detection is the capacity to guarantee that mask-wearing regulations in public areas, workplaces, and other contexts are followed. Computer vision and machine learning technologies are used by automated face mask recognition systems to determine whether or not people are correctly donning masks. These tools have the potential to monitor compliance, enforce mask rules, and assist create safer settings as the fight against COVID-19 continues.

Face mask detection is a system that uses image processing and computer vision techniques to determine whether or not people are wearing face masks in different settings. During the COVID-19 epidemic, this technology has become more important for enforcing mask-wearing regulations and safeguarding public health and safety.

Usually, cameras or other imaging equipment are used by automated face mask recognition systems to record people in public, at work, or in other environments in real time. The system can determine if a person's face is covered by a mask and whether it is being worn properly, covering the mouth and nose, by analysing these photos or video feeds.

The contributions in light of the state-of-the-art are listed below.

- Even if there are several safety measures to protect against COVID-19, face masking and social separation remain important considerations. Therefore, it was imperative to bring several face masking techniques under one roof for the scientific community.
- The suggested study analyses numerous works in the field of face mask detection with relevance to contemporary needs. Face masking has been the

subject of numerous publications; yet there are still many gaps in terms of observations, potential trends, a large number of references, current trends, etc.

- The effectiveness of the review paper is improved by comparing and discussing the performance parameters of various algorithms.

II. MOTIVATIONS

As COVID-19 cases increased over time, people were advised to exercise caution, stay vigilant, and take all reasonable precautions. Safety always comes first in instances like this, where one person's sneeze might injure several others. It is necessary to have a system that can independently detect whether or not a face mask is being used in order to safeguard everyone's safety. Not only would it protect the individual, but also the other men in the area. With access to cutting-edge technological techniques, putting such a system in place might benefit society.

A. Literature Survey

In recent years, numerous experiments and researches have been conducted on face mask recognition systems. Numerous scholarly investigations have emphasized the efficaciousness of these systems, highlighting their capacity to augment precision, productivity, and utility in a variety of contexts.

The study on face recognition by P. Gupta, N. Saxena, M. Sharma, and J. Tripathi (2018) presents a novel use of a deep neural network, which is a different kind of deep network. Instead of supplying raw pixel values as input, this suggested method just provides the derived face characteristics. Rather than using raw pixel values, face characteristics are sent into the Haar Cascade to extract facial features. Additionally, by use DNN rather than Convolutional Network, the procedure is lighter and quicker. Since the average accuracy attained using the suggested technique is 92.05%, the accuracy of the framework is not compromised.

A paper titled "An Automated System to Limit COVID-19 Using Facial Mask Detection in Smart City Network" by A. Chavda, J. Dsouza, S. Badgujar, and A. Damani (2020) have suggested a two-stage architecture. Stage 1 receives an RGB raw picture as input. All identified faces in the picture are extracted by the face detector. In Second stage, the intermediate processing block's processed ROI is collected and classified such that the dataset also includes pictures of people misusing face masks or concealing their faces with their hands, which are categorized as unmasked faces.

In a paper released in 2020, Vinitha & Velantina suggested a system that focuses on how to identify a person with a masked face in an image or video stream using a deep learning algorithm and computer vision. It makes use of libraries like PyTorch, OpenCV, TensorFlow, and Keras. There are two phases to the project's implementation. The first part involves training a deep learning model, while the second involves applying a mask detector to a live image or video stream. OpenCV is the framework used to do real-time face detection from a camera video. Python-based computer vision has been used to develop the COVID-19 face mask detector using a dataset.

One paper, published in 2020 by R. Bhuiyan, S. Khushbu, and S. Islam, describes how the suggested system renders faces utilizing the sophisticated YOLOv3 architecture with the goal of identifying the masked. By using hidden layers, research, and simple algorithm retrieval, YOLO (You Only Look Once) connects to CNN and becomes capable of identifying and locating any kind of image. The first step in execution involves feeding the model with 30 distinct pictures from the dataset and integrating the output to provide predictions at the action level. With an average frame rate of 17, our model produces outstanding results inside videos.

In 2019, T. Meenpal, A. Balakrishnan, and A. Verma presented a face identification technique called semantic segmentation, which divides each pixel in an image into face and non-facial categories. It effectively builds a binary classifier before dividing the fragment into smaller parts. Using RGB photos with localized objects, the design enables you to produce precise face masks for human things. With an average accuracy down to the pixel level, the author presented the findings on the Multi Human Parsing Dataset.

B. Objectives

The main objectives of Face Mask Recognition System can be summarized as follows:

- By guaranteeing adherence to mask-wearing regulations, face mask detection aims to promote public health and safety. The device attempts to lower the danger of virus transmission in confined areas and public spaces by recognizing those who are either not wearing masks at all or are wearing them incorrectly.

- Businesses, organizations, and authorities establish mask mandates and rules, which are enforced in part via face mask detection devices. These devices assist in maintaining mask wearing regulations and fostering a safer atmosphere for everybody by automatically recognizing non-compliant persons.
- One of the other goals of face mask detection is to reduce the possibility of COVID-19 spreading by proactively detecting and resolving cases of mask-wearing protocol noncompliance. By being proactive, we want to reduce the likelihood of viral propagation in congested environments and high-traffic regions.
- By automating the mask compliance monitoring process, face mask detection systems can improve operational efficiency. This makes it possible to identify non-compliance in real time, allowing for prompt interventions and lessening the need on human resources for manual enforcement.
- Data gathering and analysis about mask-wearing behaviour is also made easier by face mask detection technologies. Organizations and public health authorities can obtain insights into adherence levels and places where intervention may be necessary by collecting data on compliance rates and patterns.
- Real-time Alerts and Notifications: Providing real-time alerts and notifications upon detection of non-compliance is one of the goals of face mask detection systems. This makes it possible to take prompt remedial action, including reminding people or notifying staff to step in as needed.
- Integration with Access Control Systems: Face mask detection may occasionally be used with access control systems to manage access to particular spaces or establishments according on mask compliance. The establishment of regulated workplaces with improved safety precautions is supported by this integration.
- The goal of face mask detection technology is to be scalable and adaptive to different contexts and circumstances. Whether at retail establishments, transit hubs, academic institutions, or medical facilities, the technology seeks to provide an adaptable way to encourage mask compliance.

III. FACE MASK RECOGNITION SYSTEM USING DEEP LEARNING MODEL

The methodology for developing the Face mask Recognition involves a systematic approach encompassing several key stages, each crucial for achieving the project's objectives.

- Collection of data
- Image Preprocessing
- Split the data
- Training the model
- Testing the model
- Implement the model

A. COLLECTION OF DATA

Data collection for face mask detection entails obtaining visual data in the form of pictures showing people wearing, not wearing, and wearing face masks improperly.

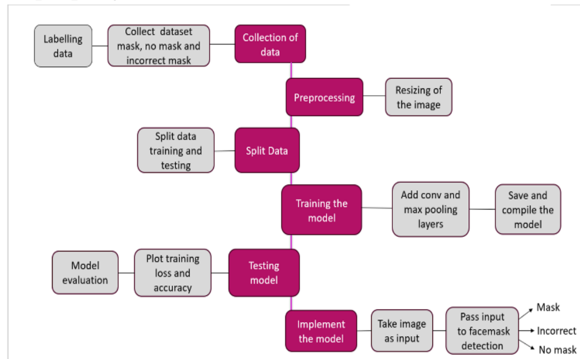

Fig. 1. Structure of Face mask recognition system using CNN

This data is used as the basis for creating efficient face mask detection systems, testing detection algorithms, and training machine learning models.

Data should be gathered from a variety of situations and environmental factors. To make sure that the resultant detection models are reliable and sensitive to fluctuations in the actual world, this may require taking pictures of people wearing masks in various lighting situations, angles, distances, and settings.

The acquired data should include people using a variety of face masks, such as surgical masks, fabric masks, N95 respirators, and other designs, to improve the generalizability of detection models.

This variability aids in the system's recognition of various mask materials and styles. The annotation and labelling of the gathered photos or video frames is a crucial step in the data collecting process.

In order to determine if a face is masked or not, as well as whether masks have been worn wrongly, this entails designating locations of interest, such as faces and masks, and assigning appropriate labels. Precise annotations are essential to detection model evaluation and training.

To guarantee that the visual data collected is of the highest calibre and faithfully depicts the intended situations, data gathering operations should uphold consistency and quality control.

This might entail following recommended methods for data gathering, validating annotations, and routinely calibrating imaging equipment. After reviewing these all conditions we have prepared three folders with mask, without mask and mask weared incorrect.

B. Image Processing

A key component in the creation of efficient face mask detection systems is preprocessing. The incoming visual data is subjected to preprocessing processes prior to being analysed by detection algorithms.

The purpose of these procedures is to improve the data quality, account for differences in imaging settings, and get the data ready for precise mask recognition. In order to improve visual quality and clarity, image enhancement techniques adjust the input images' contrast, brightness, and sharpness.

These adjustments can help mitigate the effects of lighting conditions and ensure that important features, like facial contours and mask details, are more discernible. The visual data is standardized using normalization techniques, such as colour channel normalization or pixel value scaling to a common range.

By doing this, the effects of variations in lighting and colour balance among several photographs are lessened, improving the consistency of the data for analysis.

The size of input photographs is standardized using resizing and cropping procedures to make sure they meet the specifications of the detection algorithms. This can lessen the effect of unimportant background factors and maximize processing efficiency.

To locate important face landmarks, contours, or regions of interest within the input photos, preprocessing may use feature extraction procedures. Subsequent mask detection methods may use these extracted characteristics as inputs.

C. Split The Data

"Splitting the data" usually refers to the act of separating the available dataset into distinct subsets for testing and training in the context of face mask recognition. Evaluating and validating the performance of the trained models is an essential phase in the development of machine learning models.

The machine learning model is trained using the training data subset, which makes up most of the dataset. In this project we have used 70% of the dataset for the training. To reduce the discrepancy between its predictions and the actual targets, the model learns from this subset throughout the training phase.

The trained model's ultimate performance is assessed using the testing data subset. Neither the training phase nor the hyperparameter tuning procedure make use of this subgroup. It functions as an untested dataset to evaluate the model's generalization ability to novel, untested cases. The rest of the 30% of the dataset is used for testing phase.

D. Training the model

A critical stage in machine learning is model training, in which the model gains knowledge from the given dataset and modifies its parameters to provide precise predictions or classifications. During the training phase, the model is iteratively given the training data, its predictions are compared to the labels that are known, and the model's parameters are adjusted to minimize the discrepancy between the predicted and actual values.

We have selected CNN algorithm which is suitable to our project. The training data is delivered to the model in batches throughout each training cycle, also called an epoch. By transferring the incoming data through its layers and using activation functions and mathematical processes, the model generates predictions through a process known as forward propagation. Until a halting condition is satisfied, the predetermined number of epochs are repeated. One whole loop across the entire training dataset is represented by each epoch. The model gradually gains better at making correct predictions by displaying the training data more often and modifying its parameters. CNN architecture shown in figure 2.

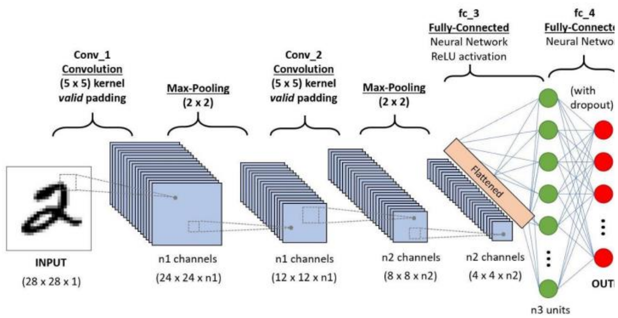

Fig.2.Proposed CNN structure

E. Test Model

To assess the performance of the model, use the testing dataset. This entails running the photos through the model and contrasting the output with the ground truth labels (i.e., masking, unmasking, or masking a face erroneously).

Determine and evaluate performance measures, including confusion matrix, accuracy, precision, recall, and recall, to determine how effectively the model generalizes to new, untested cases. To learn more about the model's performance, visualize the predictions it makes on the testing dataset. Training and validation accuracy of the proposed model shown in figure 3.

This might entail looking at cases that were correctly categorized as well as cases where the model might have made mistakes. To increase the model's performance, think about making incremental changes to its design, fine-tuning its hyperparameters, or adding more data augmentation approaches based on the testing 11 findings. Consider using the model for inference to identify face masks in photos or video streams in the actual world if its performance satisfies the required standards. Loss of train and validation shown in figure 4.

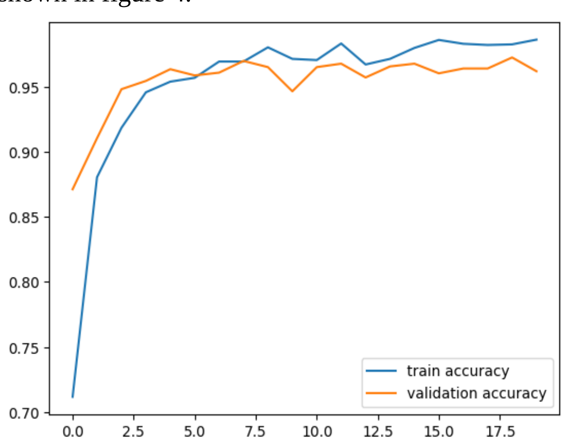

Fig.3. Training and Validation accuracy of model

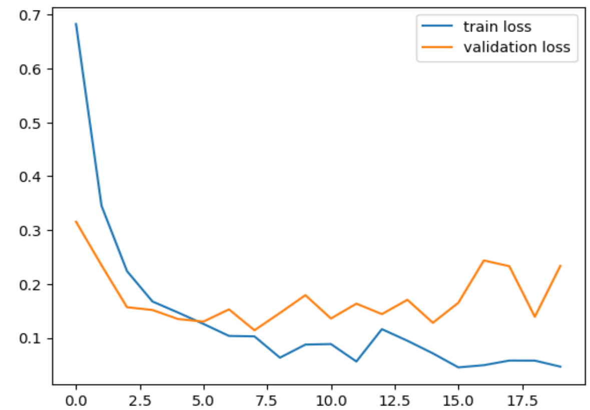

Fig.4. Loss of Train and validation of model

F. Model Implementation

Now we need to save the model which we have trained. The input picture must then be pre-processed in the same manner as the training images. This usually entails normalizing pixel values, scaling the image to the input size that the model expects, and doing any necessary data augmentation or changes.

After preprocessing the input picture, it may be fed through the deployed model to make an inference. Predictions from the model will show whether or not the face in the picture is mask-wearing. Class probabilities will be the output.

The probabilities are then compared to get the maximum probability value and its respective class values. Based on the class values if it is 0 it shows as “not wearing mask”, if it is 1 it shows as “wearing mask”, if the value is 2 it shows as “incorrectly worn mask”.

In the same way we capture the video frames continuously and, in the frame, it shows whether the person is wearing mask correctly or incorrectly or not wearing mask at all.

IV. RESULTS AND DISCUSSION

A. Experimental setup

Developed CNN are applied on Windows 10 OS that have Intel core processor and 4GB RAM and are performed in Python.

B. Dataset used

Having seen multiple datasets related to face mask detection on Kaggle, one dataset which stood out contained 3 classes (with mask, without a mask, and wearing mask incorrectly), unfortunately, the dataset was highly imbalanced and uncleaned. So, to improve this dataset, images had to be augmented in such a way that each class has an equal distribution of images and removing noisy images which could be considered as outliers. Thus, this dataset that I've created is a combination of an existing dataset that has been cleaned and equally distributed across each class.

Fig.5. User With Mask

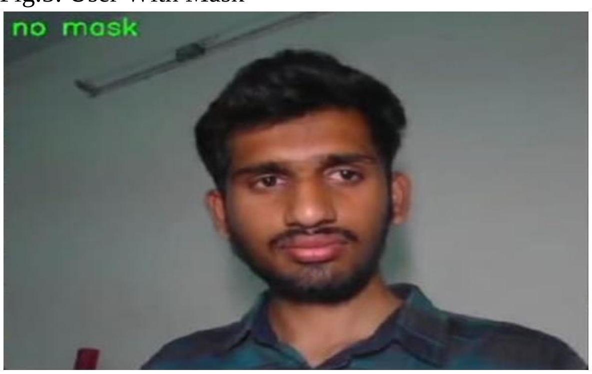

Fig.6. User without Mask

Fig.7.User mask weared incorrectly

The dataset contains 3 folders labelled as to which class they belong to. the 3 classes are "with mask", "without mask", and "mask weared incorrect". Each folder holds 2994 images of people that belong to such a labelled class.

V. CONCLUSION

In computer vision and image processing, Convolutional Neural Networks (CNNs) have shown to be a potent and efficient technique for face mask identification. Researchers and developers have developed powerful and accurate algorithms for determining if people are wearing face masks in pictures or video frames by utilizing CNN. A mask for the face CNN is a useful and promising method for determining whether or not someone is wearing a face mask. It can precisely analyse facial photos and make predictions about the presence or absence of face masks with a high degree of accuracy by utilizing the capabilities of deep learning and convolutional neural networks. The use of CNNs for face mask identification has aided in the creation of automated systems that support public health and safety, especially when it comes to the prevention and control of contagious diseases. These devices might be very helpful in enforcing mask-wearing regulations, keeping an eye on compliance, and supporting group efforts to stop the spread of infectious illnesses. CNNs are expected to be at the forefront of face mask detection research and development as computer vision and deep learning continue to evolve, spurring more innovation and advancement in this crucial application area. It is possible to characterize the outcomes of face mask detection systems using performance measures like accuracy. These measurements shed light on how well the system can identify the presence and absence of face masks. The output will be a frame which consists of the video and at the top the frame it displays whether the person is with mask or without mask or incorrect mask. The accuracy of the model is 96.82%.

VI.FUTURE SCOPE

Future developments and applications in a variety of fields are very probable for face mask identification utilizing convolutional neural networks (CNNs). Public Health and Safety: CNN-based face mask detection systems are probably going to be a part of public health and safety initiatives for a while to come, particularly when it comes to controlling infectious diseases. These systems can help create safer settings in public areas, workplaces, and transit hubs by monitoring compliance, enforcing mask regulations, and so on.

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