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Analysis of Facial Recognition using Image Processing

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A B S T R A C T

People identification is a difficult subject that has garnered a lot of attention in recent years because to the pandemic COVID-19. Contact-based technology has many applications in several industries. Face recognition is one of those difficult issues, and there is currently no approach that gives a comprehensive answer to all cases. Face recognition is a critical application of image processing in both still photos and video. It is a tremendous challenge to create an automated system that can detect faces as well as humans. The major goal of this study is to assess the relevance of CNN, different datasets used in face recognition systems, and explore the various CNN models. Deep learning advance CNN classifier used for facial recognition to improve authentication security.

Keywords:Advance CNN, Face recognition, Deep Learning.

1. Introduction

During COVID-19, FACE recognition became a particularly active field of study due to increased security, non-touching needs, and its potential commercial and law enforcement uses. Because of the demand for computer technology, everyday acts are increasingly being handled electronically rather than utilising pencil and paper or face to face. With the advancement of computer technology, there is a growing need for quick and precise user identification and authentication. Understanding user authentication is critical since it is a critical step in preventing unauthorised users from accessing sensitive information. Biometric identification technologies include fingerprint recognition, face pattern recognition, voice recognition, and typing writing. Because to skin deformation, fingerprint recognition is less accurate. Due to background noise, voice authentication is difficult to progress, and if the user has a cold, the person will not be recognised as a match with enrolee.

For human identification, face recognition is now popular and frequently utilised. A human facial attribute varies from person to person. The only item required for facial recognition is a camera. As a result, it provides low-cost, dependable personal identification that may be used in a variety of industries. A good facial recognition system can identify and authenticate users quickly and accurately. It is useful in a variety of applications, including government and commercial use, security gates, attendance monitoring, smart cards, access control, and biometrics.

The idea of face recognition system is the ability to recognize human face from image /video.

Face recognition system has mainly two parts,

1. Face Detection
2. Face Authentication

Face detection: It is the process of finding human face in an image or video Figure 1 represent example of face detection..

Face authentication: Facial recognition is a way of identifying or confirming an individual's based on facial features.

Facial recognition is a technique for authenticating persons based on their facial traits. Various techniques, such as Gabor wavelet-based solutions, Face descriptor-based methods, and Eigen face-based approaches, have been used in the past to do facial recognition. Because of its high frequency and excellent recognition rate, CNN has been used for facial recognition.

Convolutional neural networks (CNNs) are a form of artificial neural network with one or more convolution layers that are mostly used for image processing, classification, segmentation, and other auto-correlated data. Deep learning is an artificial neural network based on machine learning that recognises objects in images by gradually extracting characteristics from input through higher layers. To teach the CNN to detect faces in images, as demonstrated in the picture, we must first train it with human faces. The capacity of CNNs to construct an internal representation of a two-dimensional

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picture is a benefit of utilising them. This enables the model to understand the position and size of faces in a photograph. After training the CNN, it can detect faces in images, allowing one to successfully employ Convolutional Neural Network for Image Data. CNN that extracts picture characteristics.

Figure **Error! No text of specified style in document.** Face Detection

WORKING OF CNN

- An picture is nothing more than a two-dimensional collection. We must first analyse the dataset before we can train a picture. We mean transforming each image into a NumPy array when we say we're processing the dataset. Each row depicts a different picture. NumPy is a built-in function. The datasets are entirely ready for the model to train on.
- Neural networks are similar to layers. Each layer of a neural network has nodes that compute values depending on attributes or weights. For hidden layers, the activation function is Relu, while for output layers, the activation function is either sigmoid or SoftMax.
- A convolution layer is a fundamental mathematical technique that is extremely effective for detecting visual characteristics. We pass kernel across this layer. Specifically, n*n matrix over the picture pixel. Each cell in the kernel has a value. It is processed with the original picture to provide some features that aid in the identification of photographs of the same item while forecasting.
- Max The pooling procedure entails sliding a two-dimensional filter across each channel of the feature map to extract the most features from the picture. A pooling layer is used to minimise the size of a feature map. It decreases the number of parameters to learn as well as the amount of processing required. The feature present in an area of the feature map created by the convolution layer is summarised by the pooling layer.
- Flattening When we have multidimensional output and wish to convert it to a single long continuous linear vector, we use the flattening process. The flattened matrix is sent into the fully linked layer as an input.
- Completely Connected Layer It is a completely feed-forward neural network. It was produced by the last several layers. The outcome of convolving, pooling, and flattening the picture is a vector. This vector serves as the input layer for an ANN, which subsequently detects the picture normally. Each synapse is given a random weight; the input layer is weighted and fed into an activation function. Every neuron in the following layer is connected to every other neuron. The output is then compared to genuine values, and the resulting error is back-propagated, i.e., the weights are re-adjusted, and the process is repeated. This is repeated until the error is decreased or the output is right. One of the most difficult aspects of creating CNNs is altering the weights of individual neurons to extract the proper characteristics from pictures. Training is the process of altering these weights to produce the desired outcome.

MobileNet

Deep neural network models, such as VGGNet16/19, GoogLeNet, ResNet50, and others, have been developed by researchers. These have performed admirably when compared to typical classification methods. People continue to expand the network in order to improve accuracy, resulting in massive storage demand and computing stress. Traditional CNN has high memory and compute needs, making it impractical to execute on mobile and embedded systems.

2. Image Processing

Image processing seeks to convert an image into digital form and apply some procedure to it in order to obtain a better image or extract useful information from it. It is a technology that is being developed to transform images into digital form and execute various operations on them in order to obtain particular models or extract important information from them. This technique takes as input a video segment or a picture, such as a photograph. The output matches to the intended or attention-grabbing portion of the image. Figure 2 shows the generic process of the image processing.

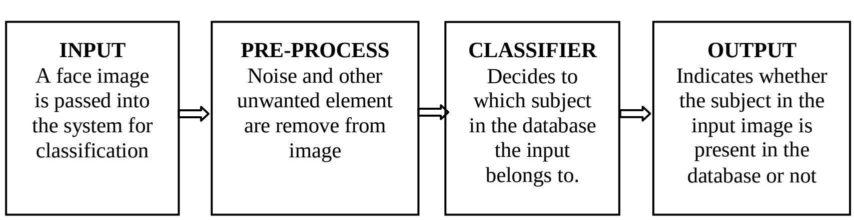

Figure 2Generic representation of a face recognition system

Open CV

OpenCV is an abbreviation for Open-Source Computer Vision. In a nutshell, it's a set of functions for image modification, image processing, and real-time computer vision.As previously said, face detection is not an easy process. In reality, there are literally thousands upon thousands of "tasks" or traits that may be used to identify and differentiate a face. These are referred to as "classifiers." These classifiers are trained using hundreds of samples of an item and random samples-positive and negative examples, respectively. If the region is likely to include that item (or face), the result is "1," else it is "0."

3. Proposed Methodology

The proposed method divided following parts

- Data collection
- Train the system
- Test the system
- Calculate the precision and accuracy of the system

Data collection

1. Taking normal images of faces
2. Creating a custom CV script to add face masks to them download from koggle.com

Data Collection without mask

Now, you must configure your camera and connect it to your system. The camera should work properly to avoid any issues in face detection. Before our camera recognizes us, it first has to detect faces. We'll use the Haar Cascade classifier for face detection. It is primarily an object detection method where you train a cascade function through negative and positive images, after which it becomes able to detect objects in other photos.

In our case, we want our model to detect faces. OpenCV comes with a trainer and a detector, so using the Haar Cascade classifier is relatively more comfortable with this library. You can create your classifier to detect other images as well.

Taking data from koogle.com around 1918 and save in data set as without_mask folder in jpeg format

Figure **Error! No text of specified style in document.** Dataset without mask

Data Collection with mask

Taking data from koogle.com around 1915 and save in data set as with_mask folder in jpeg format

Figure 4 Dataset with mask

Training Model

1. Start with an image of person without mask
2. Apply face detection to compute the bounding box location of face.
3. Extract face Region of Interest (ROI)
4. Get image of a mask, and align it on top of the face properly.
5. Repeat the steps for multiple images

Now the model can identify faces, you can train it so it would start recognizing whose face is in the picture. To do that, you must provide it with multiple photos of the faces you want it to remember.

After creating the dataset of the person's images, you'd have to train the model. You'd feed the pictures to your OpenCV recognizer, and it will create a file named 'trainer.yml' in the end.

In this stage, you only have to provide the model with images and their IDs so the model can get familiar with the ID of every image. After we finish training the model, we can test it.

Testing

For testing point of view run the trained model. After run the model camera on and take face image without mask and with mask. Trained model get the percentage of image match with and without mask images.

4. Result Analysis

This section describes simulation results and performance parameters observed are accuracy, precision. Result analysis part can be divide in three parts

1. Train the system
2. Test the system
3. Calculate the system performance

The hardware and operating environment of the experiment is shown in Table 1 and Table 2.

Table 1Hardware Requirement

Processor	Intel i7, 8th Gen quad core
Clock Speed	1.8 GHz
RAM	16 GB
Storage	500 GB SSD
GPU	Nvidia MX

Table 2 Software Requirements

Distribution	Anaconda Navigator
API	Keras
Library	Tensor Flow, OpenCV
Packages	Matplotlib, numpy, pandas, scikit Learn, Imutils,opencv-python, scipy
Language	Python
IDE	Spyder, Jupyter Notebook

Training Part

Open the Jupiter notepad on anaconda using Python platform. Import all necessary library including MobileNetv2 from tensor flow. Further infortsklearnpreprocessing and model for CNN. Initially set the linear regression rate 0.0001, for 20 epoch andBatch Size=32, import matplot library for ploting the figure

Further, create the directory for dataset as with mask and without mask and load the image as 224x224.

Now load the MobilNetV2 for the input images as tensor input shape 224,224, 3. Where 3 is represent RBG. Head model combined with base model. Average Pooling 2D size 7x7. Further, activate the model as dense of 128 and dropout 0.5.

Now fix the model as batch size and validate the data as per 20 epochs. Each epoch take the running time around 186 second.

Now find the accuracy of the model. Further, run the system model and get the output as shown in Figure 5.

```
Epoch 18/20
95/95 [==============================] - 176s 2s/step - loss: 0.0345 - accuracy: 0.9895 - val_loss: 0.0280 - val_accuracy: 0.
9935
Epoch 19/20
95/95 [==============================] - 175s 2s/step - loss: 0.0309 - accuracy: 0.9898 - val_loss: 0.0271 - val_accuracy: 0.
9922
Epoch 20/20
95/95 [==============================] - 164s 2s/step - loss: 0.0242 - accuracy: 0.9947 - val_loss: 0.0303 - val_accuracy: 0.
9922
[INFO] evaluating network...
24/24 [==============================] - 23s 884ms/step
              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
```

Figure 5 shows the output of real time for the proposed model related to face recognition.

TESTING PART

Now test the system model for a testing image getting as real time image on screen as shown in Figure 6.

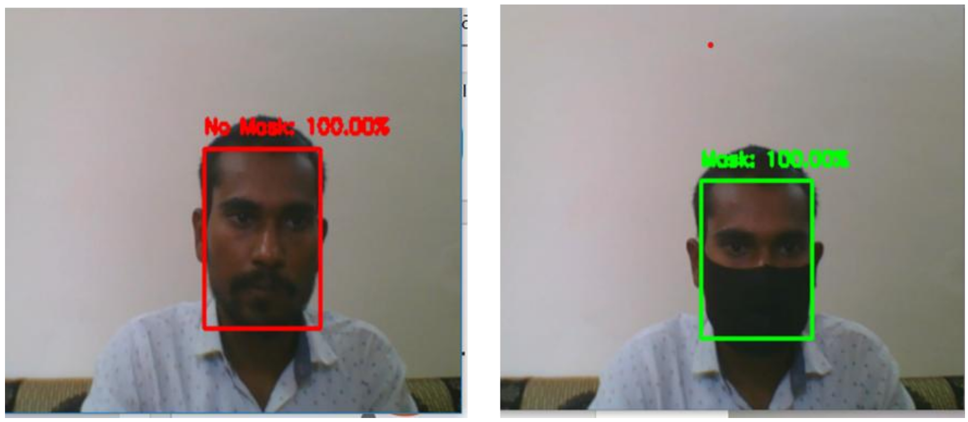

Figure 6 Output without mask and with mask

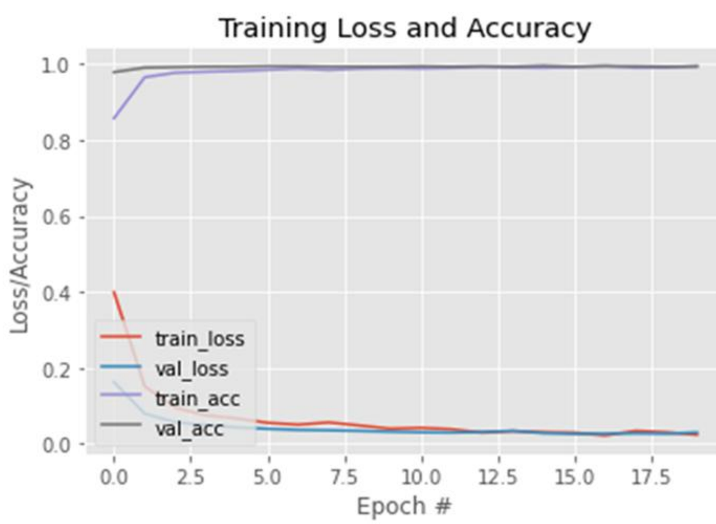

Figure 7 Plot of the system performance

Figure 7 represent the training loss is less than 30% whereas the accuracy 99%.

Table 3 Comparison of accuracy with different method

Reference	Method	Accuracy
[2]	2D-DCT	86.84%
[14]	GFC	100%
[22][29]	SVM	99.7%
[34]	2D-DCT	81.36 %
Proposed	Advance CNN	100%

Table 3 shows the comparison of race recognition accuracy of the different system model presented by some authors with proposed model of this work. The two-dimensional discrete cosine transform (2D-DCT) given 81.36 and 86.84% accuracy of the face recognition model proposed by [34] and [2]. The Support Vector Machine (SVM) given the accuracy 99.7% of the face recognition model proposed by [22] and [29]. Whereas Gabor-Fisher Classifier (GFC) proposed by [14] and advance CNN proposed in this work both gives the accuracy of face recognition system as 100%.

5. Conclusion

The inclusion of Artificial Intelligence to solve Computer vision tasks has outperformed the image processing approaches of handling the tasks. In this work proposed model performed in three-part data collection, system training and system testing.

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The advance CNN model trained to face recognition dataset for without mask and with mask image detection, achieved a validation accuracy of 99 % where the real time testing is around 100% for without mask and with mask face recognition.

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