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A Review on Performance Enhancement of Deep Learning Based Face Detection System

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Abstract: It is difficult to identify faces since most individuals used masks during the COVID-19 epidemic. The NIST 2020 study states that the current state of the art approaches for facial recognition have an error rate of 20% to 50% when the mask is used. Lately, a plethora of academics have said that they would solve this issue utilizing CNN and other approaches. To positively identify people in certain instances, researchers combined characteristics from the mask-covered and unmasked parts of the face. There is a substantial mistake rate when using these two characteristics or scenarios to identify faces. To get around these problems, you may utilize tools like Principal Component Analysis (PCA).

Keywords: *Convolutional Neural Network (CNN), Face recognition and Principal Component Analysis (PCA)*

1. Introduction

When a person uses a face recognition system, one method it checks their identification is by comparing their picture to a database of known traits. To do this, we need to measure and identify the specific facial features of everyone in the given image or video [1]. The main components of face recognition are phase verification, face identification, and clustering [2]. All these parts have their purposes; for example, a criminal identification system or an identity authorization system that employs facial recognition [3]. However, video surveillance systems that can recognise many persons in a single picture might benefit from face recognition [4]. Images taken both before and after the epidemic are shown in Figure 1. Half to eighty percent of their faces is covered by masks because of the epidemic [5]. Accordingly, the error rates of conventional face recognition algorithms have increased from 22% to 50% [6]. This high error rate hinders face recognition applications, which need a dependable technique for mask face identification that can equal the accuracy of the benchmark method [7]. Many researchers have lately tried to implement masked facial recognition; however, their approaches have failed owing to insufficient robustness. Two methods exist for recognising faces while they are hidden: Method based on reconstruction.

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DISCARD APPROACH

(a) (b)

Fig 1. Images of a public gathering image (a) prior to pandemic, picture (b) after pandemic.

RECONSTRUCTION-BASED APPROACH

To recognize the face, researchers most often reproduce the blocked part. [8] used face symmetry to reconstruct facial information to recognize facial characteristics. Their investigation started with a data collection of facial photos from different perspectives. To recognize a face, first locate its landmarks and establish whether part of the supplied face picture is missing. Use the same landmark information to find the same face in the database and integrate both photographs to recreate the face. Because the disguised facial landmark is hard to distinguish. A 2D photo can reproduce a 3D face for 3D face recognition, as seen in [9]. Despite requiring minimal training data per individual, this facial recognition method works. By beginning with the 2D face photo, this technique generates a 3D model for each class. We used the landmarks in the input test image to build

a 3D face, which we then compared to our dataset to determine its health. Moreover, half of the sites in the input photo were recognized by the researchers.

2. Discard Approach

By using a scaling filter to exclude the unimproved face piece, the author can choose the top fifty blocks of the image as the non-occluded facial component, discarding the remaining obstructed areas. After that, they used a convolutional neural network (CNN) model to sort the images, which isn't great at identifying face masks as it can't pull out the details that the mask hides. It is difficult to identify victims of facial injuries due to the wide variety of masks available. All a person's facial features, obscured and not, are part of it. A recent work [10] introduced a mask learning technique for building mass directories using PDSN. This strategy analyses two identical images of the same individual, one with an obstructed portion and the other with a normal one. Next, we feed CNN an unknown image, and it goes through a series of convolutional layers until it reaches the fully connected layer, where the processing stops. This feature map will have sections that is omitted. The feature maps for the masked region may be deleted from the mask directory. Consequently, they possess traits associated with the partly concealed face. The author of the study [11] set out to improve the accuracy of face identification for all kinds of occluded facial photographs as this method cannot detect masked faces or other obstructed facial pictures like those with bread, sunglasses, or similar obstructions. After extracting features using Facenet [12], the next steps were taken by MTCNN to recognize and crop face areas, and finally, by Support Vector Machine (SVM) to classify pictures. The dataset they used includes occluded and non-occluded pictures. Masks cover 50% to 70% of a face and mask images have similar characteristics during feature extraction. Since two people's faces must have 50–70% features, this method has poor identification accuracy.

Some researchers have recently shown results of masked and non-masked face recognition using principal component analysis (PCA) [13]. Their method successfully deciphered veiled faces in the range of 68% to 73%. Although principal component analysis (PCA) was used to extract key features from a masked facial image, the occlusion prevented it from selecting the most appropriate Eigen faces. Consequently, the rate of identification decreased.

Researchers used 3D face recognition algorithms to reconstruct the obscured portion of a face, according to many literature studies. If they constructed a 3D model of a face, and they want it to be able to identify faces, the input test picture must include very few features and landmarks [14]. Another approach that scientists have tried to use for face recognition has similarly been unsuccessful since the occluded parts of a face do not contain any distinguishing features [15]. Not only that, but several academics tried and failed to use deep learning and other approaches to detect masked faces without removing the mask. Reason being the algorithm was able to reach a minimum of 50% similarity across all faces since the mask was present in all the face photos [16].

The study suggests an image-based reconstruction method that might be used to partly restore the obscured area of a face mask picture [17]. The area around the mask has been carefully cropped out of the final picture. However, facenet is most employed for feature identification and face recognition., principal component analysis (PCA) is employed as a reconstructive method. The method of face reconstruction is the article's most significant contribution. By analyzing the part of the face that is not obscured, this research was able to reconstruct an obscured face, as seen in the article.

After this, the paper is structured as follows. Chapters II and III detail the system's architecture, while Chapters IV and V detail the approach, issue description, and goals. Section V delves into the last thoughts.

3. System Architecture

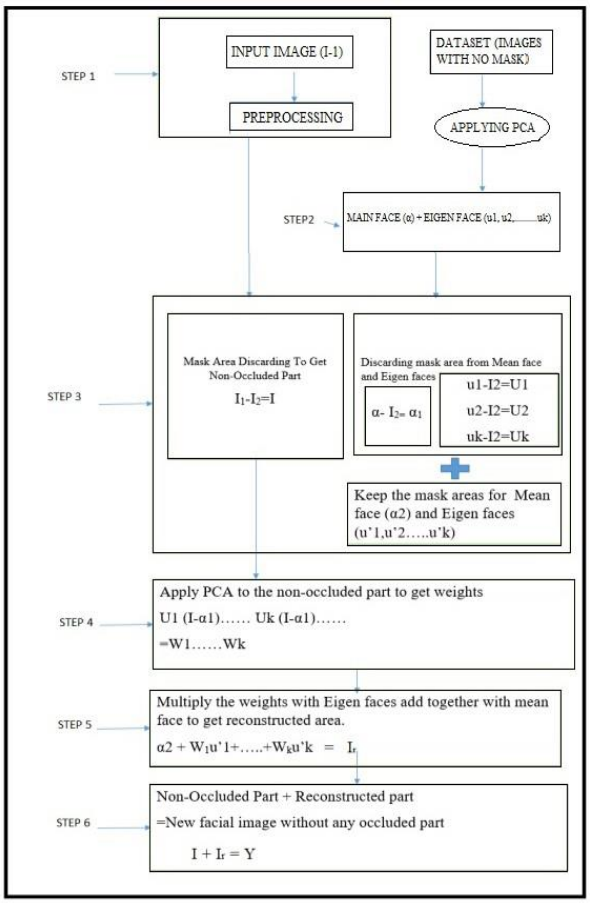


Fig 2. System Architecture.

There are two sections to the system architecture.

1. Facial Reconstruction

2. Face Recognition

1. The first part (facial reconstruction)

There are six phases below that address the rebuilding phase.

First thing to do: The photographs of every individual are included in the dataset. The input photographs and the images in the dataset were identical in terms of face area and size.

Step 1, "I1," accepts and pre-processes the user-provided test picture. Analysis was PCA.

The second phase involved identifying the Eigen faces (u1, u2..., uk) and the mean face image (α), with uk being the kth Eigen face.

With the input test image's mask removed, the non-occluded region, "I2," was generated. "I1" refers to the de-masked section. The same region was removed from both the mean and the rejected Eigen face area, and the rejected mean face region are recorded in a different directory with the abbreviations α2 and u'1, u'2, u'3, and u'k, respectively.

Proceed to Step 3 to obtain the average face 'α1' by removing "I" and then multiplying by the Eigen faces "U1, U2, Uk."

Step 4: The weights are obtained by multiplying the Eigen faces. Pictures "I" determine the weights.

Step 5 involved reassembling hidden faces by adding the mean face image to the product of weights (w1, w2, wk) and discarded Eigen faces (u'1... u'k).

To create a face picture Y free of obstructions, step 6 is to combine Ir and I.

2. The Second Half (Face Recognition)

Many face detection studies have utilized various methods. They used neural networks to recover and vectorize the dataset's visual features [18], [19], [20] The next stage was projecting the vector representation onto a unit hyper sphere. This dense vector representation of a class is called embedding. The updated "Y" vector representation of the supplied test image lined up with the people embedding when it was projected onto the unit hyper sphere.

Our face-recognition model was trained on training data. See "Fig. 3".

Fig 3. Average face from the dataset used for training. [12]

4. Methodology

It is possible to discern which facial features have been affected and which ones have not according to the approaches used. This is a list of the four approaches:

1. Use masking tape to identify and remove unwanted areas.

2. PCA.

3. The obstructing section is rebuilt.

4. Persons' identification

1. Use masking tape to identify and exclude certain locations.

A rectangular pair of When the mask and the target have distinct sizes and shapes, the Siamese network technique comes in handy. Only a face mask, which lets us see through the obscured area, fits our situation. Everything in the mask area has been removed and thrown away. The whole system has not become too complex since no specific strategy or approach has been used.

When it comes to facial recognition, here are some solid guidelines:

1. Assists in the search for those who may be lost and enhances the organization of images.
2. A revolutionary new technology, face detection, has the potential to alter our future lifestyles. The implementation of this fresh framework into society, however, is not without its dangers and implications, as is the case with every novel concept.

The following are a few drawbacks of face detection:

1. It restricts individual liberty.
2. It leads to deceit and other criminal acts.

2. Principal Component Analysis.

PCA is a popular method for estimating the most significant Eigen vectors and Eigen values in a dataset. PCA is used to generate Eigen vectors and Eigen values that best show the non-occluded area of the face. The face mask was removed from both the normalized photo (mean face) and the original picture to identify the uncovered regions.

Eigen faces finding non-occluded part main components.

Some nice PCA prons:

1. Enhances algorithm performance.

2. Reduces Overfitting.

3. Enhances visualization.

Here are some drawbacks about PCA: -

1. The interpretability of independent variables decreases.

2. You must standardize your data before running PCA.

3. **The obstructing section is rebuilt: -** Many studies have reproduced the occluded face utilizing the basic components from the previous step. Image main components may be represented by combining the normalized image and principal components. Face recognition requires many photographs of everyone. Everyone's normalized picture, or mean multiplied, was produced from this dataset. Getting the Eigen faces and Eigen values to stand in for the unobstructed portion of the input picture was the last step. Then, after multiplying the Eigen values by matching Eigen faces, the normalized image (mean face) was added. The veiled area's reconstruction was all they were able to get, however. At last, the normalized image (mean face) was combined with the reconstructed masked area.

Reconstructing "Fig. 4" displays the training dataset Eigen face. Eigen face main components and weights were calculated from a non-occluded input test picture. We multiplied weights by Eigen vectors and added the mean face to the rebuilt picture. Original and replicated test photo in "Fig. 5". valid points here healing the blocked area.

1. The idea enhances still-image systems by using video redundancy.

Reconstruction of the obstructive section is a nice example of a scam.

1. Problems with image similarity increase

4. Personal identification

Several scholars have used various approaches to identify the people. like Facenet, a convolutional neural network, and several more. There are a few approaches that can identify people with little to no restrictions.

The reasons for naming the persons in question are as follows:

1. It depicts a group of individuals.

2. Even with some blurriness, it identified the picture.

Among the drawbacks of naming the people are: -

1. At a certain distance, the pictures are hard to make out.

2. The precision is reduced when the picture is not aligned correctly.

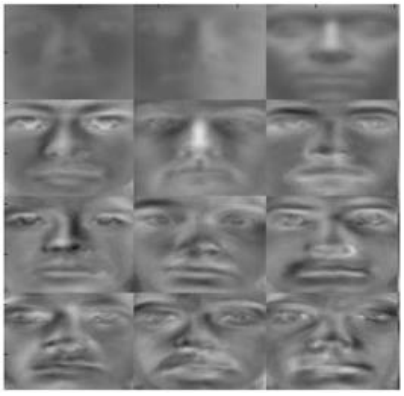
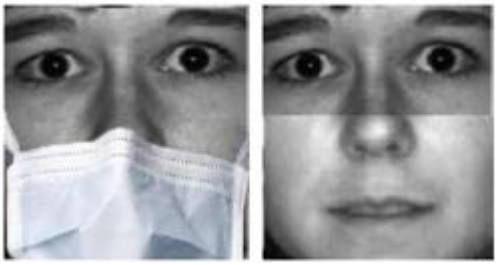


Fig 4. Eigen faces. [12].



(a) (b)

Fig 5. The input photo and the replicated image were looked at [12]

Ref. No.	Author	Method Used	Advantages	Limitations
[1]	Susanta Malakar et.al	Principal Component Analysis (PCA)	Occluded part accuracy up to 15% Partial facial recognition	The enclosed portion cannot be constructed with precision. Improves facial recognition accuracy when faced with partially obscured or obstructed faces.
[2,4,12, 14]	Muhammad Ihtisham Amin et.al, Jinu Lilly Joseph et.al, Yelanati Ayyappa et.al, Xiu Jie Qu et.al,	Convolutional Neural Network (CNN)	Among masked faces, recognition accuracy was at 97.67%. Accuracy in facial recognition was 67.18%. Pick out seven different expressions on people's faces. Analysis of facial expressions performed automatically.	Complex systems take longer to implement in real-time. The app has only been released on Android. Feel more things. There isn't any other method to record a moving image. Raise the rate of recognition. Another layer of protection, like retina, might be applied.
[3,13]	Nitendra Mishra et.al, Harikrishnan Sudarsan et.al,	Local Binary Pattern (LBP), Gabor filter	Taking pictures is a breeze.	Detection and identification time for video preparation reduced by more than 90%.
[5,6]	Paras Jain et al. Andres Espinel et al.	Deep Learning Methods, Deep Perceptual Mapping	Removing their masks exposes their faces.	In crowded environments, such as lecture rooms, it is difficult to recognize faces.
[7,19,20]	R. Satheesh Kumar et.al	Deep Learning Methods, VGG	People can recognise faces at a glance.	When recognizing facial features, it must be more
	Vallabhaneni Sri Harsha et.al, Dane Brown	Face Model	Appreciation of how students act and express themselves	consistent. Recognizing student expressions when they are moving might be challenging.
[8,15]	Ali El mahmudi et.al Kolipaka Preethi et.al	Neural Network, LBHP (Local Binary Histogram Pattern) Algorithm	You can capture static photos. Attendance is automatically logged, and images are recognized.	The security framework for face recognition has improved its performance. Update on attendance of many individuals.
[9,16,17]	Chandra Prabha K et al., Shubham Gupta et al., Asep Hadian Sudrajat Ganidisastra et al.	BPNN (Back Propagation Neural Network)	A robust system for recognizing faces will emerge.	Quicker and more precise convergence.
[10,11, 18]	Mohammad Abuzneid et.al, Meijin Lin et.al Radha Guha et.al	Support Vector Machine (SVM), Local Binary Pattern (LBP), Histogram of Oriented Gradient (HOG)	Better identification results with smaller sample sizes.	Maybe it will fix overfitting. The accuracy of automatic face recognition might need some work.

Table 1. Comparison of Previous Methodologies.

The recommended solution uses improved face reconstruction technology. The novel strategy outperforms the current approach for masked face photographs in face recognition. It is possible to reconstruct the obscured portion of a face by studying the unobscured portion. All photos in the dataset should be front-and-centre, and the suggested solution can't fix the broken section. We want to enhance the future results of the rebuild.

5. Conclusions

We noticed in numerous research publications that state-of-the-art algorithms cannot distinguish maskable faces and that deep learning improves face identification accuracy. This article proposes a deep learning-based approach to do so.

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