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Identification and Recognition of Facial Images

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ABSTRACT

Face detection is the power to identify a face and recognition is the ability to recognize whose face it is by means of facial characteristics. Face is multivariate and requires a lot of mathematical summation. Almost all imperative applications use a face recognition system. There are many methods that have been already proposed which provides low recognition rate. Hence, the main task of research is to develop a face recognition system with higher recognition capability and better accuracy. This paper proposes Face recognition system by combining two techniques Viola Jones and Principal Component Analysis. An approach of Eigen faces is employed in Principle Component Analysis(PCA). The face recognition system is implemented in MATLAB.

Keywords: Principal component analysis, Face recognition, viola jones, Eigen faces, GLCM.

I. INTRODUCTION

A computer is a synthetic brain and we feed the data we want the computer to remember and act as per the circumstances demand at that given time. Despite human beings having the best sense of recognition sometimes fails in the subject matter due to various factors as expressions, cosmetic expressions, posture expressions and gleam and glitter expressions. The same way computers also take a dip. Quoting various surveys conducted- "The human Recognition is still far ahead in Face Recognition system". Despite of years of work on Computer Vision, Scientists from all over the world were not able to match human performance, due to lack of work on Face Recognition System but if proper Analytical data is fed into the system and conditions are strictly adjusted the Face Recognition System surely gives a hard time to human beings.

The Face Recognition system is basically a database of various faces fed into the memory of computer which increases its ability to differentiate between objects and faces and also correlate various images and ascertain the similarities in data. The challenge in face detection is to see whether the input image could be a face, whereas, in face recognition the challenge is whose face is it.

In Technology Oriented Times, Facial images for detection and recognition is a basic need of each smart technology where a system is developed to determine and find out a particular human face. The area has gained immense popularity and is being heavily chosen for research purposes thanks to its multifarious uses for increased crimes, biometric analysis, crowd surveillance, human computer interaction(HCI). However, there are some constraints that produce the detection and recognition of face difficult to perform artificially like different faces on basis of age, skin and color. A number of other obstructions include incompatible amount of light incident on face, hidden face proportion, orientation, tilted face detection, multiple faces detection. However, the great pandemic Covid19 has made sure that every person covers their face which has made Face Recognition more challenging while wearing mask.

This paper presents a novel approach for face detection and recognition. There are various methods for detection and recognition of facial images. Here for Detection of Face Viola Jones algorithm has been used and for Recognition Principal Component Analysis has been used.

II. FACE DETECTION PROCESS

Face Detection application uses an Algorithm which determines whether images are positive or negative i.e. images contains faces and images without faces. Viola Jones algorithm is one among the widely used algorithm for Face Detection. There are 4 steps for detection of face through Viola Jones [1].

1. Haar Feature Selection: - The images are divided into rectangular windows or regions of size MXM, then features are calculated for every region separately. They are used for feature extraction. There are 3 kinds of Haar like features that Viola Jones identify i.e. Edge features, Line features and Four-sided features and thus we get an Integral Image.

2. Integral Image: - In this step, we calculate the worth of every feature. Any rectangular Area will be calculated in sum of upper and left-over values of an image.

3. Adaboost:- It help in finding only the most effective features. In general, we have 1,60,000+ features out of which all are not useful. So Adaboost filters the features which are irrelevant and selects only those features which are relevant. These features are called as Weak Classifiers and Adaboost constructs a robust classifier as a linear combination of these weak classifiers. These Features are utilized in deciding whether a given window includes a face or not.

4. Cascading:- In this stage, features are divided into stages and every stage has a certain number of features. The job of every stage is to determine whether a given sub window is definitely not a face or may be a face. A sub window is straight away discarded as not a face if it fails at any stage. If all stages are passed, we get a face.

Fig-1: Detection of group of face

III. FACE RECOGNITION PROCESS

Principle component Analysis (PCA) is one among the fore- most popular method for feature selection and is additionally called Karhunen-Loeve Method. Face recognition using PCA was first done by Turk and

Pentland. The main idea of PCA is that it reduces the dimensionality of the information. The simplest and effective approach of PCA is Eigen faces. The basic characteristic features of a face are nose, eyes, mouth and these characteristic features are called as Eigen faces. These Features will be extracted by means of mathematical tool PCA. Each original image of training set is transformed into Eigen face. Recognition is finished by projecting a new image in eigen face subspace, after which person is assessed by comparing its position in Eigen face subspace with position of known individual.

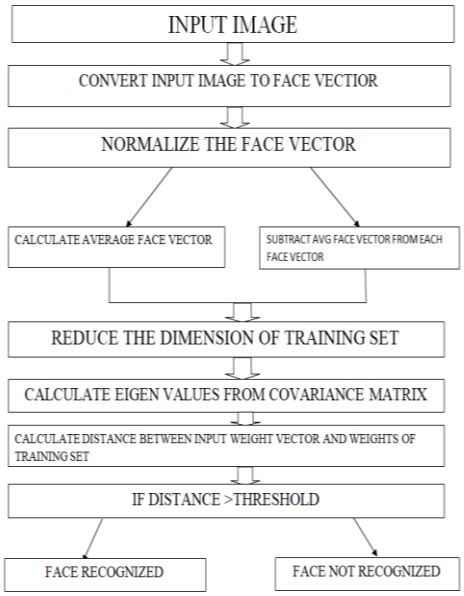

Fig-1: Working of PCA

PCA works by creating a training set of N images with N*N Dimensions [10]. After having a Training set, Recognizer needs to be trained in which first step is converting each face in Training Set into a Vector form as PCA does not directly work on images but for it actually convert these images into vector form.

After Conversion into Vector Form next step is Normalization. It means to remove all common features that these faces share together so that face is left with only their unique Features. For Normalization, first step is to find common features known as Average Face Vector, after which average face is subtracted from each of the face vector to get normalized face vector. The training graph is shown below

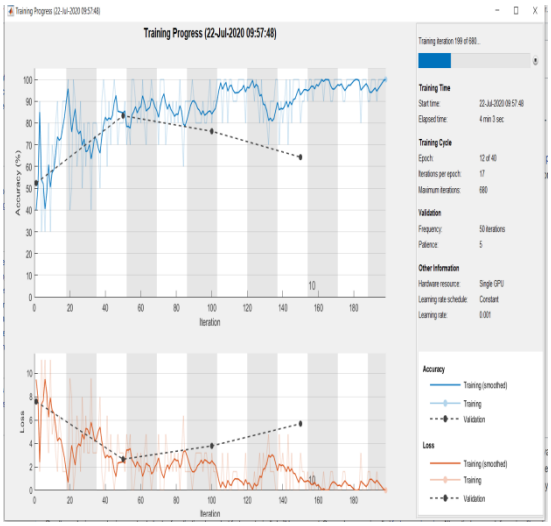

Fig-3: Training progress

Next to calculate Eigen vector first calculate the covariance matrix 'C'. It is given by the formulae A into A^T where A is just a matrix with each column being equal to normalized face vector. Dimensionality reduction is performed to reduce calculations and effect of noise on needed eigen vectors. The calculations are performed from a covariance matrix of Reduced Dimension. i.e.

Cov=A^TA which is simple reverse of above Covariance. Now to find Eigen Vector from Reduced Dimensionality Covariance is easier. Once we have Eigen Vectors, the best Eigen Vectors need to be selected [11]. Then calculate the distance between the input weight vector and the weights of the training set. If the distance is greater than the threshold than only the face is recognized else face not recognized.

IV. DATABASE DESCRIPTION

We run the train database and test database on self-created database. The database is a collection of different facial images. The images are captured from I-phone XR with 12-megapixel camera with an f/1.8 aperture. The database includes 19 perceptible subjects with each subject having 8 images with resolution 100*100 pixels containing some female and some male images. All the images are in JPEG format. Some of the

images are covered with scarf, some wearing spectacles, with different illumination condition like dark, bright and normal lightening conditions. In the database, we have store 2 images of each person in test database and 6 images of each individual is stored in train database. The images that we will choose in test database must be different from the test database.

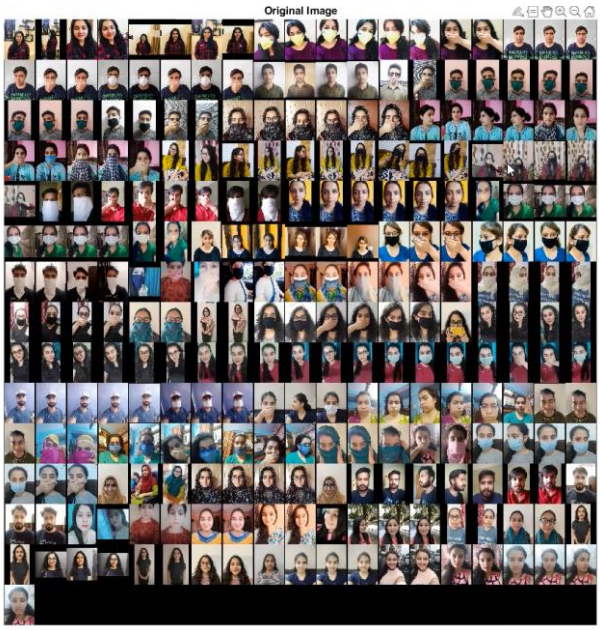

Fig-4: Collection of datasets

V. IMPLEMENTATION OF PROPOSED METHOD

For implementation PCA, Deep Neural Network and Multiple Support Vector Machine is used so that faces can be detected and recognized both when face is covered with mask and when not covered by masks as masks has become a basic necessity nowadays due to covid-19. People nowadays are very much conscious so in order to take precautionary measures, every individual always cover their face with masks. So, in such critical situation, the recognition of face has to be done with covered faces. Therefore, for the detection of objects neural network is used [4]. The overall success rate is around 88%.

A. Proposed method

We have developed an Algorithm that overcomes the drawbacks of PCA. It is able to recognize faces when covered with masks or without masks and also while wearing spectacles or without spectacles under different lightening conditions and backgrounds.

Face recognition is performed in six steps

1. Input Image: - Coloured images are chosen as input images both with and without masks. The faces in the image need to be partially covered but not fully covered. All the images should be captured from same camera with same pixels.

Fig-5: Input images

2. Pre-Processing: - All the images need to be pre-processed before face detection and recognition is performed. It means that all the noise from images will be removed. With the help of noise removal and hole filling techniques false detection rate of faces will be reduced.

3. Face detection: - For face detection, Viola Jones algorithm is used. This algorithm helps to detect the face. Vision Cascade Object Detector function is used that detects the face in any given image. For processing, fast integral image representation is used that reduces the calculation.

4. Face cropping: - Once the face detection is done, face is cropped from the input image. Cropped face is easy to handle as it contains less but accurate information and then is converted into Gray scale as shown below.

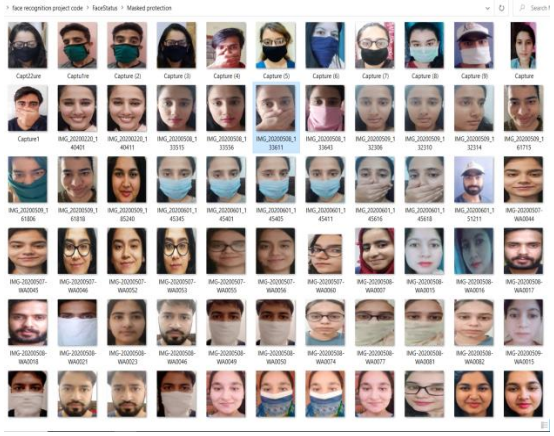

Fig-6: Cropped faces

Fig-7: Gray-scale faces

5. Feature extraction: - The number of features in a dataset is reduced by creating new features from the existing set and discarding the original features. It is basically attribute reduction process. It can be used to enhance the speed and effectiveness of supervised learning.

Level Co-occurrence Method (GLCM) is a feature extraction technique that has been used here, which characterizes the texture of any image by calculating pixel with specific value and a specified relationship occurs between an image, thus creating a Level co-occurrence method (GLCM) and then extracting statistical measure from matrix. It uses Gray co-matrix function that creates a Gray level co-occurrence matrix by calculating how a pixel with Gray level value 'i' occurs in a specific spatial relationship to a pixel with value 'j'. So basically, subtracting the original face from the mean face and the result which we will get is a completely unique face. Here white pixel part represents the unique features and black pixel part represents common features and is shown below.

Mean image

Image subtracted from mean image

Fig-8: Feature extraction

6. Feature Matching : - It matches the features with the dataset and the most resembled face will be the desired output. In order to increase the speed k-d search tree is used here to find the similarity of the features which will give us the final result of recognition from the database.

VI. RESULTS

A GUI (Graphical user interface) has been created for results in both manual recognition and real time recognition for both covered and uncovered faces. A separate button has been created to identify mask status of the image.

The GUI for manual recognition consists of 2 buttons for selection of image and for recognition. The accuracy of this experiment is 95% for uncovered images and 91% for covered images.

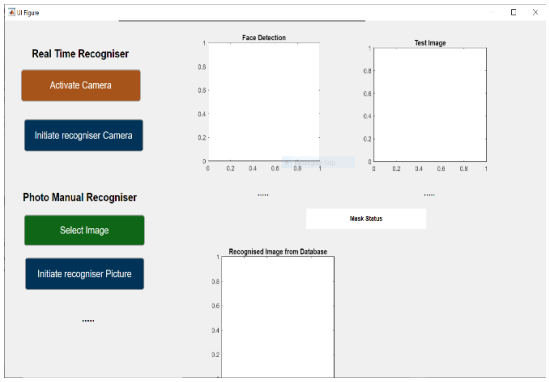

Fig-9: GUI for face recognition

Real time recognition also consists of two buttons one is for activating the web camera and another button is for recognizing the image captured by web camera. The accuracy of this experiment is 90% for uncovered images and 87% for covered images. When the face is covered it shows masked status with green colour and when the face is uncovered it shows the mask status as red. Along with mask status it also shows the details of an individual like name, age and gender. The results of the experiment are shown below and the accuracy is mentioned in the table below

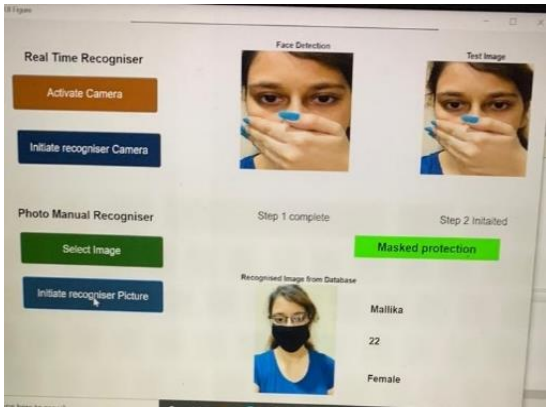

Fig-10: Result when image is selected manually with mask status as covered

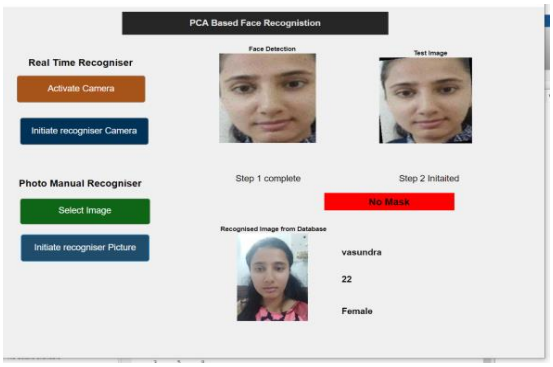

Fig-11: Result when image is selected manually with mask status as uncovered

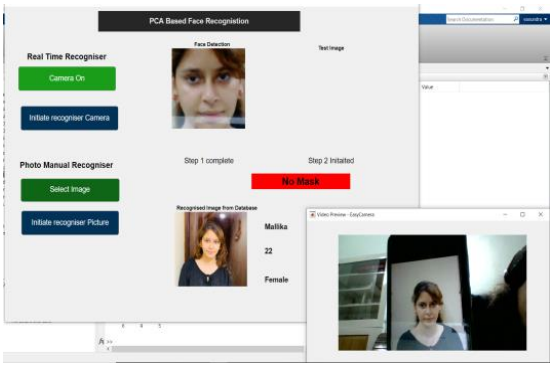

Fig-12: Result when image is taken from real time with mask status as uncovered

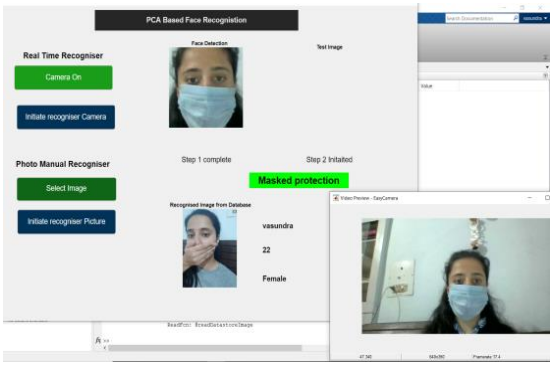

Fig-13: Result when image is taken from real time with mask status as covered

Table 1: showing accuracy with different approaches

PCA Approach	Accuracy
Real time recognition with covered faces	87%
Real time recognition with uncovered faces	90%
Manual recognition with covered faces	91%
Manual recognition with uncovered faces	95%

VII. CONCLUSION

Face recognition is a highly satisfactory and successful process in many types of applications such as biometric security, voter databases to reduce duplicate registrations, digital image of a person which can be used as a password and many other important activities. The proposed technique is applicable to both real time and manual recognition. The objective of this work is to implement a reliable Principal Component Analysis (PCA)-based face recognition system and study its performance using standard face databases and the recognition rate is quite satisfactory. In this experiment we have considered 25 images each of 19 persons so as to have more accuracy this technique will require a greater number of images of each person. Therefore, the work can be extended for recognition of faces with higher database.

VIII. FUTURE WORK

We want to extend this work by using the proposed algorithm for recognition of faces in videos with higher database. We also plan to analyse emotions associated with images both manually and in real-time.

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