Intelligent Face Detection And Recognition

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Abstract--- Human face is the identity signature that helps to identify and segregate human beings. This identity signature is dependent on number of parameters ranging from skin color, to geometry of features an contours on human face .Thus face recognition is one challenging field in biometric science .Human brain can recognize these faces despite large changes in the visual stimulus, be it the change in hairstyle, expression, aging, and distractions such as glasses or a new style of beard or many such feature change. Different approaches use the specific databases which consist of single type, format and composition of image. Face detection finds whether there is a face in the given image or not, and where it is, while face recognition finds the identity of a detected face in the image. The face detection algorithm works by locating eyes in the image and the face recognition algorithm uses Principal Analysis to calculate eigenvalues and eigenvectors of the face images. The Viola &Jones face detection algorithm is a popular, learning-based technique that is used in present-day cameras and devices. Face recognition has many issues to deal with, like the type, format and composition of the face images used for recognition. The present paper carries a performance accuracy of PCA based face recognition on different face datasets, which have large variation in lighting condition ,pose variation, age variation and face size.

Keyword: - Face detection ,Recognition, euclidean distance, PCA .

I. INTRODUCTION

Human face recognition is a very complex and challenging problem. It needs the great ability like human brains to recognize the faces. Face **recognition** is one of the many biometric ways of recognizing an individual**,** which uses computer software to determine the identity of the individual[1].Other types of biometrics include fingerprinting, retina scans, and iris scan**.** It has many uses starting with searching for an individual in a database, retrieving personal information about the individual, gaining access to data based on one's unique facial identity etc. It has many applications in forensics, tracking and monitoring, counter terrorism, prevention of identity theft, IT industries, and financial services[4].

The human faces have a lot of similarity, like the shape of faces and features among themselves, so the face images fall within a relatively small regions of the face space and thus require less knowledge to reproduce the face from the face space[21**].**Before the face recognition system can be used, there is an detection phase, wherein face is detected from the given image. After the face detection system is trained to learn the distinguishing features of each face[3]. The identifying names, together with the discriminating features, are stored in a database. Eventually, the system will have to identify an face, against the database of faces images using distinguishing features. The best match, usually in terms of distance, is returned as the identity of the probe[4]. The main problem in face recognition is that the human face has potentially very large intra-subject variations while the inter-subject variation, which is crucial to the success of face identification. Many face recognition algorithms have been devised over the past decades ,but PCA based, eigenface technique is the fastest and remarkable accurate way to recognize the face[21,23].The eigenface technique uses a strong combination of linear algebra and statistical analysis to generate a set of basis eigenfaces[21,4]. Face Recognition system can be divided into two parts first is Face detection and second is face recognition:

II. FACE RECOGNITION SYSTEM

A. Face Detection:

Face detection is a computer technology that determines the location and size of human face in image or videos[8].Various methods of face detection are:

1. Knowledge-based methods use human-coded rules to model facial features, such as two symmetric eyes, a nose in the middle and a mouth underneath the nose.
2. Feature invariant methods try to find facial features which are invariant to pose, lighting condition or rotation. Skin colors, edges and shapes fall into this category.
3. Template matching methods calculate the correlation between a test image and pre-selected facial templates.
4. Appearance-based, adopts machine learning techniques to extract discriminative features from a pre-labeled training set.

We implemented the viola jones algorithm for the face detection**.** Paul Viola and Michael Jones presented a fast and robust method for face detection which is 15 times quicker than any technique at the time of release with 95% accuracy .The technique relies on the use of simple Haar-like features that are evaluated quickly through the use of a new image representation[10].

B. Face recognition:

Face recognition algorithms are divided by [3]into three categories, as follows[17,23] :

1. Holistic methods: Holistic approaches attempt to identify faces using global representations, i.e., descriptions based on the entire image rather than on local features of the face[5]. This scheme used some statistical approaches.
2. Feature based methods: Feature-based approaches first process the input image to identify and extract distinctive facial features such as the eyes, mouth, nose, etc and standard statistical pattern recognition techniques are then employed to match faces using these measurements[7].
3. Hybrid methods: these methods used both feature-based and holistic features to recognize a face. These methods have the potential to offer better performance than individual holistic or feature based method [7]. An open

issue in face recognition is dealing of illumination, pose, occlusion and age of the human faces which affect the recognition process.

The Authors, M. Turk and A. Pentland [5] have proposed an method to face recognition using an information theory approach of coding. Decoding the face images may give insight into the information content of face images that emphasizes the significant local and global ―features. Such features may or may not be directly related to our perceptive idea of face features such as the eyes, nose, lips, and hair[11].

Principal Components Analysis(PCA) [14] based face recognition is the simplest method for face recognition[13]. **T**he main aim of the principle component analysis method is to find the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images. The eigenvectors obtained is considered as a set of features that characterize the variation in the face images. Each image location contributes more or less to each eigenvector, so that the eigenvector can be displayed as a kind of ghostly face called an eigenface[11].Only few higher eigenvector values in the training faces are kept for the computational efficiency.Some of the eigenfaces re shown below.

Fig. 1:.Eigenfaces

The eigenvector of the test face is calculated and projected to the training faces to calculate the Euclidean distance ,the face in training set with minimum distance is the best matched face to the test face. The eigenfaces are basically the vectors of the real faces. The implemented Eiegnface based system has three different phases:

1) .Create Face Data Base

1.Capture human face (detection) from the web cam or given image.
2.Create the training data set.

2) .Create Eigenfaces

1.Calculate the average of the total training faces.
2.Calculate the deviation of each image from the average face and calculate the covariance matrix
3. keep the k highest eigenvector from the M face space.

3) Recognition

1.Read the test face
2.Calculate the eigenface of the test image
3.Calculate the Euclidean distance between the projected test face and all the eigenfaces in the taken from training set(k) .
4. Best matched face will be the face with least Euclidean distance.

III. IMPLEMENTATION

The Eigenface approach of face recognition is implemented here to check, it is producing better results for different face databases that are currently used in research. For the validation we used Leave-One-Out Cross Validation (LOOCV), we kept one observation for testing and the remaining data for training.

1.Image Dataset A number of algorithms have been proposed for the face recognition and these algorithms have been tested for the different databases. That are of wide variety of poses, illumination angles, gestures, face occlusions, and illuminant colors. we are using mainly two databases for our system evaluation:

ORL Face Database(AT&T Database**)**

There are ten different images of each of 40 distinct subjects[14]. For some subjects, the images were taken at different times, varying the lighting, facial expressions (open / closed eyes, smiling / not smiling) and facial details (glasses / no glasses)[11,15,16].As an example, images corresponding to one individual are shown in the figure 2:

Fig. 2: Sample database from ORL database

The Indian Face Database

This database contains images of 61 distinct subjects with eleven different poses for each individual of male and female. All the images have a bright homogenous background and the subjects are in an upright, frontal position. For each individual, the following pose for the faces are included: looking front, looking left, looking right, looking up, looking up towards leftetc [11,17].As an example, images corresponding to one individual are shown in the figure 3:

Fig 3: Sample database from IFD database

Table 1. Face Data Specification

Database Name	Image format	Image size	Image type
ORL	Pgm	11kb	Grey
IFD	Pgm	12 kb	Grey

All the analysis were carried out on the following specified system:

Processor: Intel(R) QuadCore(PENTIUM) CPU@1.9Ghz
RAM: 2.00 GB
System Type: 64 bit
Operating System :Windows 8
Software: MATLAB R2013a

Table2: Recogniton Rate

Database Name	**Total no of unique face used**	**No of face/person used in training set**	**No of face in training set**	**Dimensions used**	**Accuracy rate (%)**
IFD	40	1	40	17	35.00
		2	80		52.19

		3	120		56.43
		4	160		60.42
		5	200		65.50
		6	240		66.88
		7	280		62.50
		8	320		65.00
		9	360		67.50
		1	40	25	37.22
		2	80		46.50
		3	120		55.71
		4	160		54.58
		5	200		59.50
		6	240		63.13
		7	280		60.83
		8	320		61.25
		9	360		63.00
ORL	40	1	40	17	65.00
		2	80		72.19
		3	120		83.21
		4	160		83.75
		5	200		86.00
		6	240		90.63
		7	280		94.17
		8	320		96.25
		9	360		100.00
		1	40	25	65.39
		2	80		72.81
		3	120		78.93
		4	160		80.83
		5	200		82.50
		6	240		93.13
		7	280		92.50
		8	320		96.25
		9	360		97.50

Experiment 1**:**The first experiment was carried out on the IFD and ORL dataset .These datasets contains small size of images and they differ in pose, illumination and face expressions.

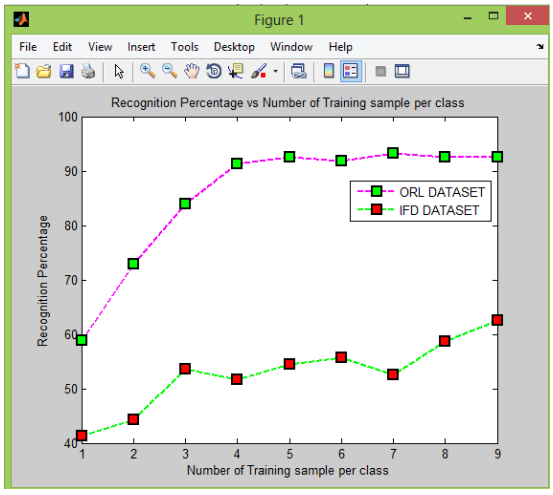

Fig. 4: Recognition Rate vs Training sample/class

Result 1: The above graph shows the percentage of recognition accuracy of the implemented algorithm on two different datasets. Although, the recognition accuracy of both the datasets increases as the no of training sample per class of the datasets increases. Recognition rate of ORL dataset is more than the IFD dataset. The reason behind this big difference is the variation in pose, illumination and different facial expression and the face image size.

Experiment 2: The second experiment was carried out on IFD face dataset. The maximum no of dimensions taken is 100.

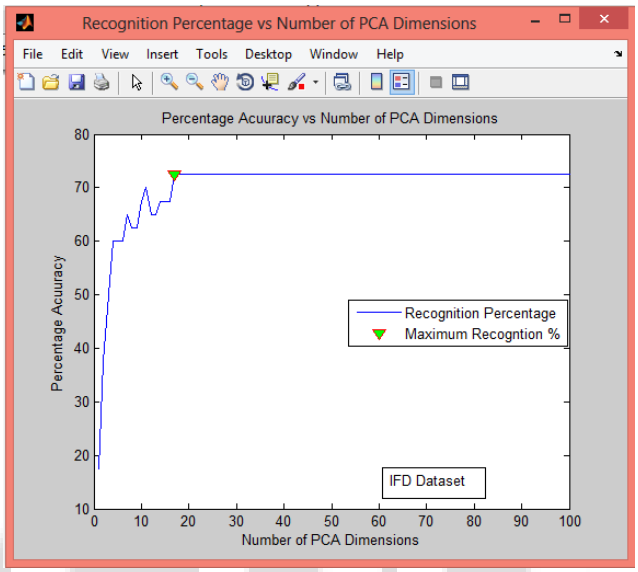

Fig. 5: Percentage Accuracy vs No of Eigenfaces (IFD Dataset**)**

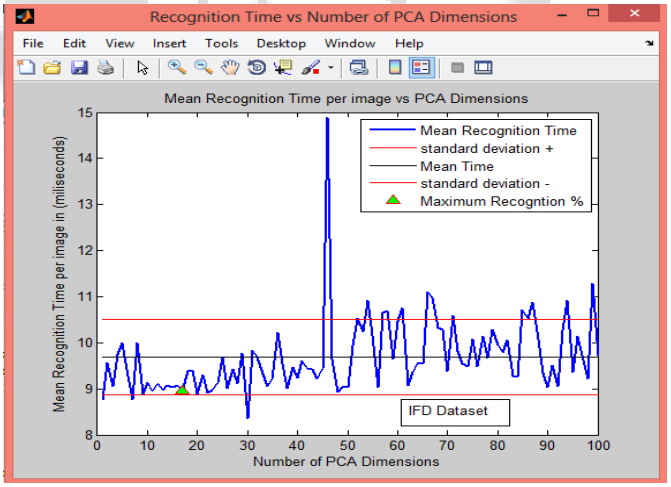

Fig. 6: Mean Recognition Time per image vs Eigenfaces(IFD Dataset)

Result **2:** The overall 72.50 % maximum recognition is achieved at 17 number of dimensions for mean recognition time per image 8.946246 milliseconds

Experiment 3: The second experiment was carried out on ORL face dataset. The maximum no of dimensions taken is 100.

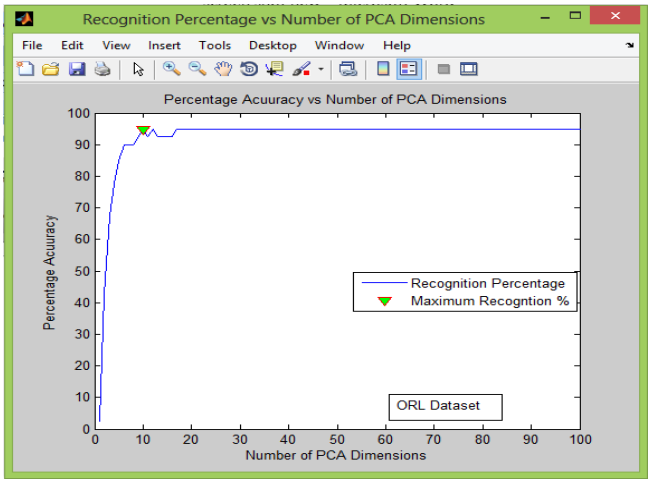

Fig 7: Percentage Accuracy vs No of Eigenfaces (ORL Dataset

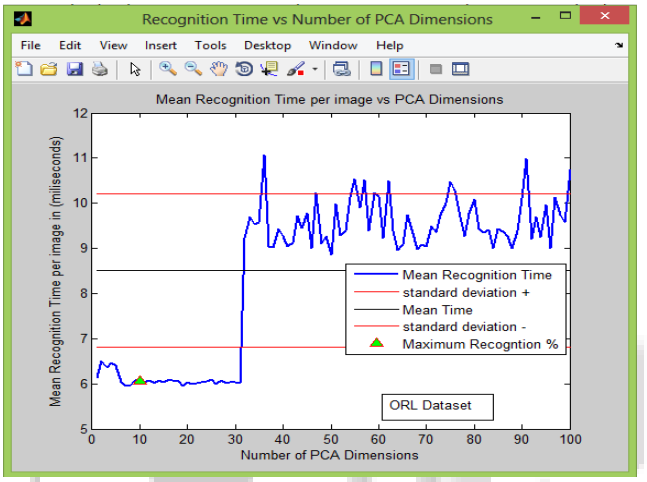

Fig. 8: Mean Recognition Time per image vs Eigenfaces (ORL Dataset)

Result 3: The overall 98.50 % maximum recognition is achieved at 17 number of dimensions for mean recognition time per image 9.946246 milliseconds

Conclusion **:** Two standard databases are used for evaluation of above results. The first database is published by IIT Kanpur [19] and the second database known as ORL face image database [20].In this paper, Eigenface PCA face recognition technique has been implemented and examined with two different face databases. The experimented result shows that around ten images per person gives better result for face recognition. But in real time scenario, collecting and storing these images for training set are not easy task. Second and third experiment show the accuracy and mean time of recognition. In case of ORL dataset the accuracy is high but the mean recognition time is high. There is a need to work and get high accuracy recognition rate for single image per person problem.

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