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# COMPARATIVE EVALUATION OF FACE RECOGNITION ALGORITHMS USING AND NON-INDIVIDUAL ALGORITHMS

**MOHSEN ZANGIAN[a1], SEYYED MOHAMMAD REZA HASHEMI[b], FARZIN YAGHMAEE[c], EHSAN MOSHTAGH[d]**

[a1]Shahroud, Science and Research, Electrical and Computer Collegeaas
[b] Department of Electrical and Computer Engineering, Qazvin Branch,Islamic Azad University,Qazvin,Iran,,
[c]Semnan, Semnan University, Faculty of Electrical and Computer College
[d]Tehran, Amir Kabir University, Electrical and Computer Collegedd

## ABSTRACT

**In this paper, the applications of face recognition system and the weaknesses of these systems have been studied; these cases that the face recognition techniques are generally divided into several categories and various techniques have been proposed for this purpose have been discussed. Furthermore, the performance evaluation criteria and general framework for face recognition algorithms have been stated. In the continuation of the article, the algorithm evaluation criteria have been examined according to it. In the section of the performance results of these algorithms, we introduce the hybrid algorithm using PCA, LDA and Gabor algorithms. Finally, they have been compared each other using these techniques in various databases such as the Yale, FEI, FERET, AR and ATT.**

**KEYWORDS;** Face Recognition; Individual Algorithms; Non-Individual; Comparative Evaluation.

Biometric systems have had a high growth in the field of identifying and studying the identity by increasing development of information technology in the recent years. In these systems, the recognition is done using behavioral or physiological characteristics of individuals such as fingerprint, face, iris, voice, signature, the way of pressing the keyboard and the way of walking. Each of these methods has its own strengths and weaknesses. Systems to identify and verify the identity by a face image aren't also excluded from this rule.

One of the biggest advantages of the recognition using the face is that the facial image is accessible easily and using cameras which take photographs and films without making troubles for others. This method has also some weaknesses that among them we can refer to factors such as changing the face because of aging, makeup or using cosmetics, mental modes such as sadness or happiness and disease and also sensitivity to change the angle, light, and photography distance.

Regarding these challenges, the researchers are always trying to evaluate the best face recognition algorithm. Different evaluations have been conducted by researchers….

Here we also evaluate eight comparison algorithms such as PCA, LDA, ICA, SVM, Gabor, PCA + LDA, ICA + LDA + PCA and the suggested algorithm of PCA + LDA + Gabor based on face recognition accuracy. In the following, we present a brief description of the above-mentioned algorithms.

## FACE RECOGNITION ALGORITHMS

### Principle Component Analysis (PCA)

This method is one of the oldest face recognition methods. This is also known as Hotelling conversion or Karhvnen-Loeve that works to reduce the dimensions in the face recognition. PCA calculates the set of the base sub vectors set for the database of the facial images. These base vectors show an image according to the face structure named a special face. The designs of the images allow the easy comparison of images with each other and the information bank in this dense subspace. The approach of face recognition consists of the following preliminary operations:

To receive a Primary set of N facial images (training images).

We calculate the special faces from the training set, the special face can reconstruct the main images of the training set with a linear combination. When a new face is introduced, the error can be calculated by comparing the new face with the best reconstruction of the new image from the special faces. If the special faces of the image data bank make a big face, the size of the error can determine whether the new introduced image is a face or not.

If the error is small enough, then the recognition will be successful and the related information to a person will be extracted from the face recognition bank and displayed.

### Linear Discriminant Analysis (LDA)

LDA that is also known as the Fisher Linear Discriminant Analysis (FLDA), is another method of reducing the dimensions. Unlike PCA, this method is a monitored method and indicates that the data of each class is used to separate the data. The purpose of this separator is to use the dependence of the data to each class. Somehow, the data of each class are closer each other and the data between classes are separated more each other.

### Independent Component Analysis (ICA)

In the method of Principle Component, the transfer vectors should be necessarily perpendicular to each other, while the dispersion of the data may not be in vectors which are perpendicular to each other in practice. Independent Component Analysis searches the best vectors so that it can model the

[1]Corresponding author

dispersion of the data by their helps and the data will be independent by transferring the data to this subspace. Bartlett and et al have suggested two ways to recognize the face using ICA. The first method is the vectors of statistical independent images and the second method is the representation of factorial code.

**Support Vector Machines (SVMs)**

Basically, SVM is a linear machine that its main idea is a super sheet as the decision-making level somehow the segregation limit is maximized between positive and negative samples. This method obtains above-mentioned optimum features using a way based on statistical instruction theory basis. More accurately, SVM is an approximate implementation from the method of "structural risk minimization".

**Gabor wavelet**

One of the most successful methods of face recognition is based on matching coefficient graph which has been obtained from Gabor filter responses. But such algorithms of matching graph have some difficulties which arise from the complexity of their matching, manual location in teaching graphs and generally high time. In these methods, a general structure of the face is used to make graphs. A new method based on Gabor can solve such difficulties.

Two-dimensional Gabor functions can reinforce the edge of the shapes, also hollows and lumps of the image. Increasing the distinctions of the eyes, mouth and nose that are mentioned as the main and basic points of the face, are among the effects of the functions. Moreover the features such as spots, facial hollows, wound effects and such cases are highlighted. Therefore, using such prominent points as the positions containing the feature, a feature map is obtained for each image based on the face and each face can be given without primary limitation using its own features.

These methods can keep the general information of the face after the reinforcement of local features by having the allocated feature map.

**PCA and LDA combined method**

A set of training and test images is reduced into a feature space. The plan of two new sets of feature vector, training and vectors can test with much smaller dimensions than the dimensions of created original image as a representative of the images then it is used to adapt the work between the test image and training pictures. The results of individual recognition from a system based on PCA and LDA are combined each other as input and a final result is achieved. Figure 1 shows a schematic design of the system.

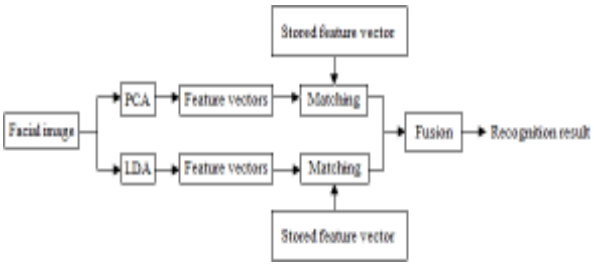


**Figure 1: Block diagram of PCA and LDA combined method**

**PCA, LDA and ICA combined method**

The proposed algorithm is a compound system that using three individual algorithms PCA, ICA, and LDA deals with the face recognition problem. And then two strategies for integrating the output of individual categories of sum rule and a RBF Network as a classification have been used which works using the adaptation of points as the input feature vector.


**Figure 2: Schematic design of a hybrid system PCA, LDA and ICA**

**PCA, LDA and Gabor combined method**

The proposed algorithm is a hybrid system with the parallel architecture and in a guess level. This system consists of three individual subsystems of face recognition that their obtained outcomes have combined each other as comparative points, by a neural network of kind of Feed Forward Back Propagation and a final result is achieved. Figure 3 shows a schematic design of the proposed system.

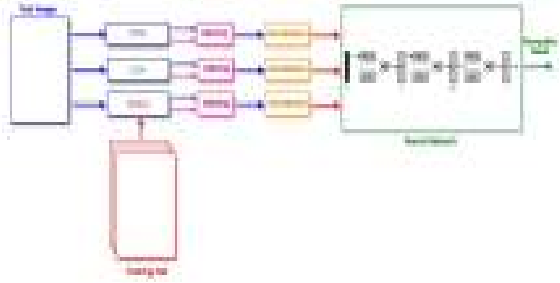

**Figure 3: Schematic design of proposed hybrid system for solving the face recognition problem**

## INVESTIGATION METHOD

In this paper, introduced algorithms have been evaluated by Yale, FEI, FERET, AR and ATT databases. The evaluation criterion of the algorithms is the rate of face recognition accuracy.

## DATABASE

Flexibility in the face and its three-dimensional complex structure causes the facial image is changed by different factors such as light intensity, head angle, facial expressions (laugh, fear, surprise, etc.), passing time, being covered and even the mode and the model of hair. The design of the face recognition algorithms requires the databases that their images will be provided to study each factors of change with great care and precision. In the following, we introduce some of these banks that have been used in this article.

### AR Database

AR database has been provided by Barcelona machine vision group in Spain in 1998 A.D (MARTINEZ, AR and Benavente, R. 1998). This database has consisted of 116 images of both men and women (63 men and 53 women).

**Figure 4: AR Bank Sample images**

### ATT Database

ORL database has been provided by AT & T Institute between 1992 to 1994 A.D (SAMARIA, FS and Harter, AC, 1994). This database has consisted of 400 images of 40 individuals.

**Figure 5: ATT Bank Sample images**

### YALE Database

YALE database has consisted of the images of fifteen persons with various facial expressions and different light conditions (BELHUMEUR, PN et al 1997). Light conditions include the illumination from the left, right and ambient light.

**Figure 6: YALE Bank Sample images**

### FERET Database

FERET database has been prepared by George Mason University and in cooperation with the U.S. Army's Research Group between 1993 and 1996 A.D. (PHILLIPS, PJ et al., 2000)

**Figure 7: FERET Bank Sample images**

### FEI Database

FEI database has been provided in Brazil FEI laboratory between 2005 and 2006 A.D. (LL de Oliveira Junior.et al., 2006).

**Figure 8: FEI Bank Sample images**

## CONSLUTION

In this paper, five facial databases have been applied for evaluating face recognition algorithms. And also these algorithms have been implemented by Matlab software.

The evaluation was conducted on the basis of recognition accuracy and obtained results by the algorithms are shown in Figure 1 using different database. It should be noted that presented values are data mean.

Regarding figure 9, the nature of the algorithms and the strengths and weaknesses of the algorithms can be examined. Studied algorithms, hybrid algorithm ICA + LDA+ PCA and proposed hybrid algorithm of the article namely PCA + LDA + Gabor have better results than other algorithms.

**Figure 9: Results of the algorithms evaluation in the various databases**

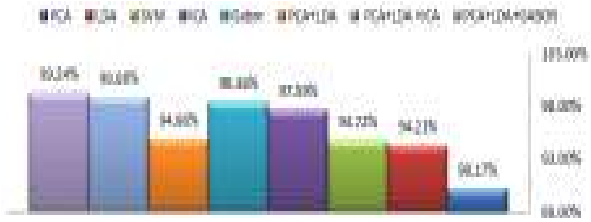

**Figure 10: Mean of the evaluation results of algorithms in the various databases**

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