International Journal of Mechatronics, Electrical and Computer Technology

Vol. 4(11), Apr, 2014, pp. 744-761, **ISSN**: 2305-0543

Available online at: http://www.aeuso.org

Giving a New Method for Face Recognition Using Neural Networks

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Abstract

The face recognition system follows generally methods and systems that can recognize the face with acceptable accuracy and speed like a human and or even better than the human. The face recognition system can be categorized into different levels, sensors, features, guess and decision; each of them has the different structures. One of the most important levels is the combination of guess and conjecture. Experiments indicate that the mentioned methods are more efficient in the layer (level) of guess and conjecture. In this paper, it is tried to show the face recognition should be considered as one of the most important biometrics features using the benefits of combined methods. The proposed method is a combined method with a parallel structure of the layer (level) of guess and conjecture and the extracted comparative benefits of three algorithms named LDA, PCA and Gabor operator that are known for the combinations. Faced Forward Back Propagation method has been used to combine the advantages of a neural network. The results of tests on Feret, AR and Yale data set show that using proposed methods can be useful to reduce the factors of external elements such as brightness and to change the reasons of the position and movement of the various algorithms and improve results. Also we can recognize the features of the face using different neural networks. The improved results in different algorithms have been shown in the mentioned data set in the following table and it is remarkable that the proposed combined algorithm of the paper, i.e. PCA + LDA + Gabor has the better results than the compared algorithm.

Keywords: face recognition, levels of hypotheses, neural networks, gabor, LDA, and PCA.

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1. Introduction

Biometric is the really the resultant of technologies in the world of communication and information, or in the other words, it is the entry key into the world of information and communication control. In the report presented by MIT University in 2000, biometrics was named among ten new technologies that will change the world. The implementation of biometric security big projects in the world indicates the importance of this technology in the future of international communications. This point can be observed by increasing the usage of a wide spectrum of applied methods and programs which benefit this technology and the last published news in this case. This paper with the title of category combinations in the level of hypotheses for the face recognition tends to introduce the methods of the recognition briefly and uses biometric face recognition and the combination of categories in the method of the face recognition. Biometric has always been considered in the form of personal recognition tools. The recognition has been considered as one of the necessities of the today world and has been evident in most areas. And in the other similar area the special tool biometric is for recognition.

The system that has been discussed in this paper for the face detection is a combined system with a parallel (architectural) structure in the level of hypotheses that consists of three separated subsystems for the face recognition. The obtained results in the form of comparative scores are combined by a neural network with Faced Forward Back Propagation method and the final result is obtained. Figure 1 shows a schematic design of the proposed system.

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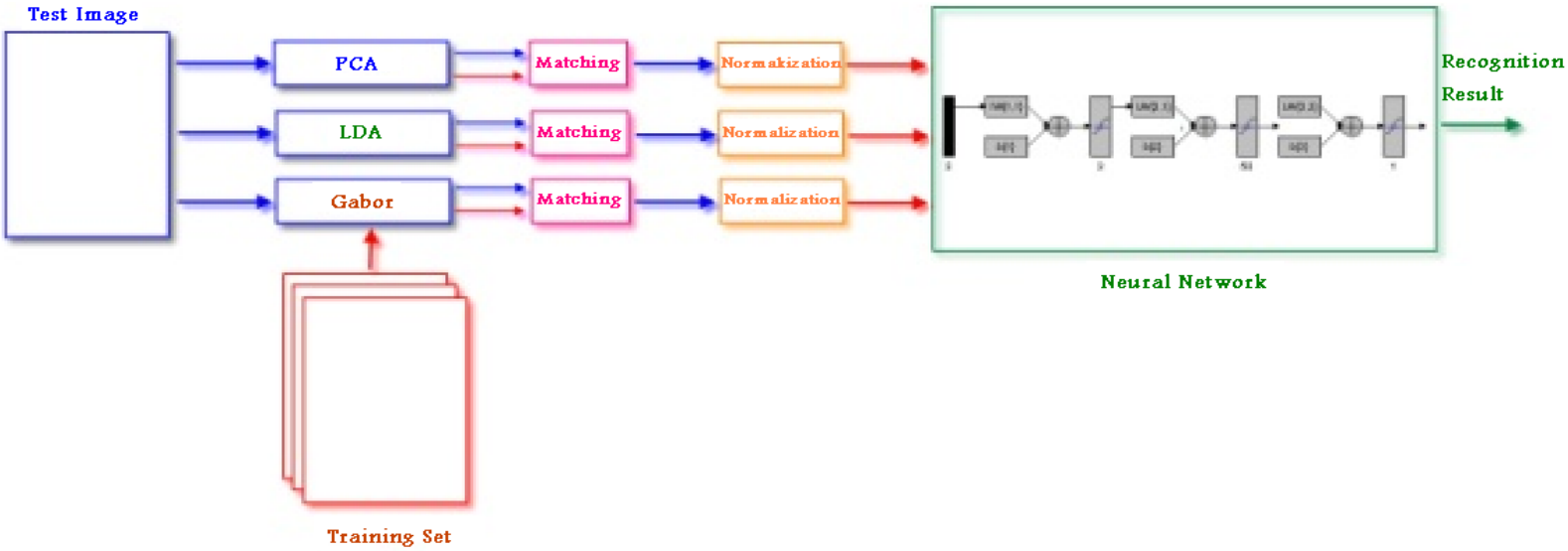

Figure 1: Schematic design of the proposed combined system for the face recognition

In this system, each of the PCA, LDA, Gabor algorithms are used to extract the features from the information bank and the test of the images (some images that have been identified for this purpose). Then the available distance between the features of each category is calculated. The various algorithms can be used to calculate these distances. In this paper, the calculation of Euclidean distance has been suggested for PCA and LDA. One kind of the same operations has also described for Gabor algorithm in the following. The obtained results of the comparison lead to recognize after the normalization by a neural network.

2. To describe the method of original parts

The face recognition system is based on images which are divided themselves into two major categories: to create the special images and to recognize / verify a new face.

2.1. To describe the method of original parts

The techniques (methods) of a specific face are still the powerful simple solution for complex issues of the face recognition. In fact, it is the best visual method for the face

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recognition. As it will be shown, the older techniques are focused on the specific features of the face. The special face technique uses more information to categorize the faces that is based on the pattern of a public face. These patterns include the special features of the face but aren't limited to them. Naturally, the pattern of a special face will be applied because we will have higher efficiency using more information than the method of the face recognition based on these features. Essentially the special face is nothing more than the initial vectors for a real face. This problem can be related directly to a basic concept in Electric Engineering with the name of February analysis. February analysis shows that the sum of sine laws in the various frequencies can reconstruct a signal completely. Thus, a set of specific faces can reconstruct a special face. In this method, the recognition and understanding of the features of the faces are a puzzle.

2.2. Fisher linear Discriminant analysis

In PCA method, more accuracy has been used to give a set of data in a similar space. In this method, the data has been presented in a line for the highest variance (difference) [1] [2] [3]. But it may not be appropriate to this direction for the categorization of the features. Figure 2 shows a set of data in two different classes. The highest difference that is observed in each group is in the vertical direction but the obtained results of the data images in this direction don't show the division and separation of the categories.

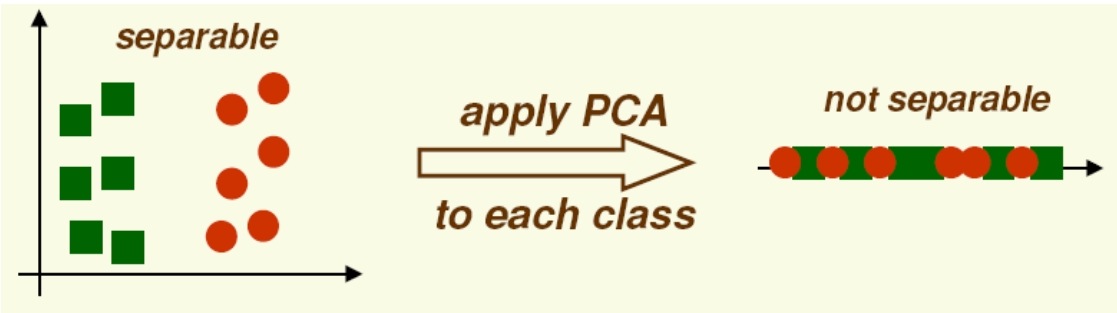

Figure 2: The Image for the highest variance doesn't lead to separate the categories in the PCA method.

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In the method of Fisher linear division FLD, the data which is presented in a line, leads to separate the categories of the image in a line. The main idea of this method is to find a line that separates the samples of different categories efficiently.

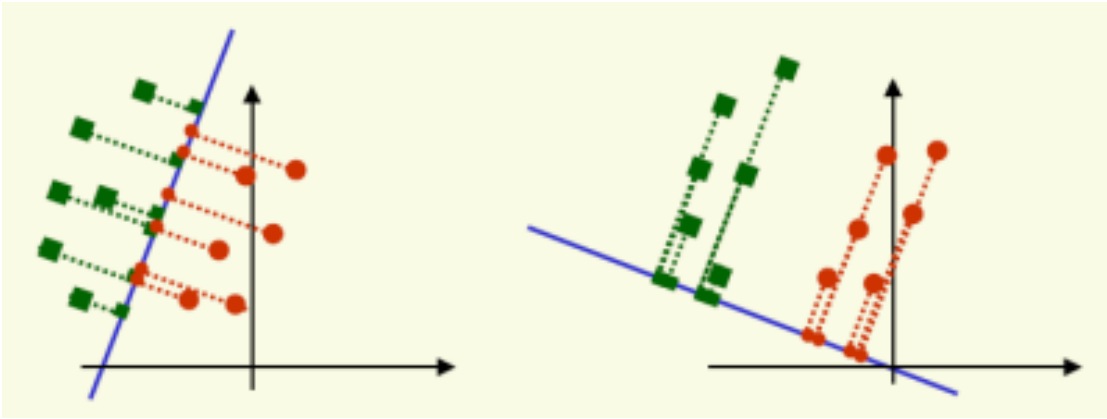

Figure 3: The comparison of the obtained results of the selected division line.

2.3. Fisher linear Discriminant analysis

Using the local features is a developed method in the face recognition. One of the main motivations for using the methods based on the giving the features, presents some images of the face that is very compact and reduces the requirement for the memory. When an information bank uses a big face, this reality has a particular importance. The methods based on the features follow the fixed points (or local points) that give the adaptation of the information in theses points. These methods are very effective and efficient, but finding the suitable points / place of features and adapting their values are very critical and important in the effectiveness of the recognition system. The Search of finding the answers of the questions led the researchers thought about this issue that how a visual system works in the human body. In physiological studies, the researchers have found the simple cells in the visual cortex that react to the frequencies of the selected space and are set and

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also it was said about the locations that the responses of these simple cells can be approximately same as Gabor two-dimensional filters.

According to recent findings, using Gabor filters can be very successful in the system of final recognition. One of the most successful methods of the face recognition is based on the obtained coefficient graph from the response of Gabor filters. But this method has some problems related to comparative complexities, positions of teaching graphs and the consumption time for us. They use the general structure of the face to create graphs. A new method based on Gabor can solve such problems. Gabor two-dimensional function causes to increase the permeability percentage in the margins of the image just as good as hollow and lumpy parts of the image. Also it causes to increase the permeability degree of the differences in the eyes, mouth and nose because they are considered as the most important parts of the face. Moreover the features such as spots, hollow parts, wounds and such cases are highlighted. Therefore using these prominent points as the places containing the features, a map of features is made for each image based on the face that can show its own special features without the initial limitations. Having the feature map for each face, this method can keep the general information after the reinforcement of the local features.

In this paper, a new method has been presented based on the maximum choice of the points (strengths). In the corresponding Elastic graph, this model uses the wave response of Gabor method in the form of the points containing the features more than the predefined graphs that it reduces Gabor wave representation potential. The feature vector has been obtained by sampling Gabor wave conversion coefficients in the points containing features.

3. Combination in the hypothesis level

The combination in the hypothesis level is really a combination of comparing the separated obtained scores from each category. In this method, there is a set of sensors and extractors of

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the features in every level that creates some categories using the information of the personal features in the form of the vectors of the feature. Every appropriate categorization to its own algorithms compares the vector of the obtained features with the vector of template features and presents the results in the form of comparative scores. These scores are combined in the process of decision-making and finally the output is obtained. Figure 4 shows the combined block diagram in the level of the hypothesis.

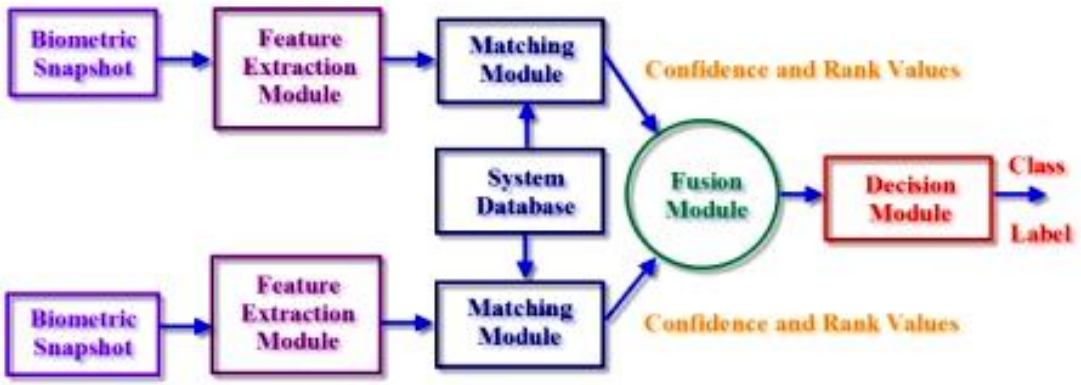

Figure 4: The combined systems in the level of the hypothesis

4. Neural Networks

As it was said for introducing the face recognition system (Figure 1), the obtained results of PCA, LDA and Gabor feature extraction algorithms try to extract the features from the known faces directly. Then this information is compared with the obtained features from the unknown faces. In PCA and LDA methods, the obtained features from unknown faces are compared with the images of known faces in the informational bank. This case is in the same line as Euclidean distance between PCA or LDA division line (the features of the unknown face) and the images of all exclusive faces in the information bank. In Gabor method, the comparison is done with obtaining the function value of the related similarity to each image. These

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results are used directly in a single system for recognizing formally. But the obtained results from the categorizations are transferred after normalization to combine with the nervous system to Feed Forward back Propagation.

The proposed neural network includes three layers, input, intermediate and output (Figure 5). The input layer consists of three neurons that receive the related values to each of PCA, LDA and Gabor neurons. The output layer has one neuron and the final result is between 0 and 1. The maximum output value shows the most similar image in the information bank to the unknown face.

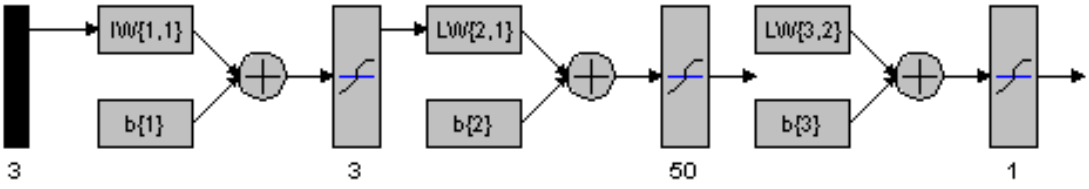

Figure 5: neural network of Feed Forward back Propagation model

Conclusion

So far, it was observed that a combination of categories is a new method to increase the efficiency and accuracy of the individual systems. In the proposed combined system, various biometric algorithms (the face recognition) have been applied and necessary knowledge is obtained in the training phase of the face features. In this section, this point will be studied that whether the system will be effective in recognizing the face and its expressions. Therefore, the combined systems have been evaluated in the different experiments and will be examined based on the obtained results such as the efficiency and accuracy, thus whether the efficiency and accuracy have been increased or not.

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4.1. To design the environment of the face recognition Azmuth test

To obtain the desired results, the test environment should provide the possibilities of accurate study and evaluation for the responses of the system in different conditions and especially its sensitivity to the various changes in the face, which includes a wide spectrum. The test environment should be quite clear and obvious. The obtained results from each of the individual systems will be presented along with the results of the combined system so that the efficiency of the combined system can be understood better.

Generally, the test environment is divided into six different cases in the selected test samples that include:

1- Using the training images of the bank information faces
2- The images of the faces with different expressions.
3- The images of the face with eyeglasses.
4- The Images of a face that some part of it has been covered.
5- Noisy images.
6- The images with unilateral lighting for the face

5-1-1- Using the training images of the bank information faces

In this section, the simplest test of recognizing the faces will be examined. There fore the images of the faces which have been presented to the instruction system are introduced to it with the title of unknown faces. Table 1 shows the results of this test.

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Table 1: The obtained results of the face recognition system using the available images in the trained information bank

The number of faces tested: 60				
	PCA	LDA	Gabor	Combinational system
Wrong	0	0	0	0
Correct	60	60	60	60
Success percentage	100%	100%	100%	100%

The obtained results show that all tests have been done successfully in both sections, whether in the section of the individual algorithms and or in the section of the combined system.

5-1-2- The images of the faces in different expressions

As already mentioned, the available challenge in the face recognition system is a wide spectrum of the face changes that causes to make more differences in the obtained results in each class. In this section of the tests, the different modes of the feeling in the face such as happiness, excitement, sadness, sleep and ... are announced to the system so that they will be studied (Fig. 6).

(A) (B)

Figure 6: The images of the face in different expressions

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Table 2: The obtained results in the face recognition system in the different emotional modes

The number of faces tested: 60				
	PCA	LDA	Gabor	Combinational system
Wrong	4	2	0	0
Correct	56	58	60	60
Success percentage	93.33%	96.66%	100%	100%

5-1-3- The images of the face with eyeglasses

Eyeglasses are in the category of the external factors that cover some part of the face features or its changes in the special expressions, its effects have been presented in Figure 7.

Figure 7: The images of the face with eyeglasses

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Table 3: The results of the face recognition system in the conditions that some part of the face has been covered with eyeglasses

The number of faces tested: 60				
	PCA	LDA	Gabor	Combinational system
Wrong	5	5	0	0
Correct	55	55	60	60
Success percentage	91%	91%	100%	100%

5-1-4- The Images of a face that some part of it has been covered

In this test, some parts of the face like the eyes, mouth, and nose have been covered and presented to the system for the recognition (Figure 8).

Figure 8: The Images of the face that some part of it has been covered

Table 4: The results of the face recognition system when some part of the face has been covered

The number of faces tested: 60				
	PCA	LDA	Gabor	Combinational system
Wrong	8	4	0	0
Correct	52	56	60	60
Success percentage	86.66%	93.33%	100%	100%

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5-1-5- Noisy images

The images which should be presented in the face recognition system have a lot of noise, in this section; the response of the system to noisy images will be examined. The available noise in the images may be in the forms of Gussian, dotted, or spotted (like scattering grains of salt and pepper) (Figure 9).

Figure 9: Noisy images

Table 5: The results of the face recognition system when the images are noisy

The number of faces tested: 60				
	PCA	LDA	Gabor	Combinational system
Wrong	6	7	4	A
Correct	54	53	56	59
Success percentage	90%	88.33%	93.33%	98.33%

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5-1-6- The unilateral lighting to the face

One of the factors that play an important role in the face recognition is the effects of the ambient light. Therefore in this section, the effects of the unilateral lighting will be studied, in a condition that one side of the face is brighter than the other side (Figure 10).

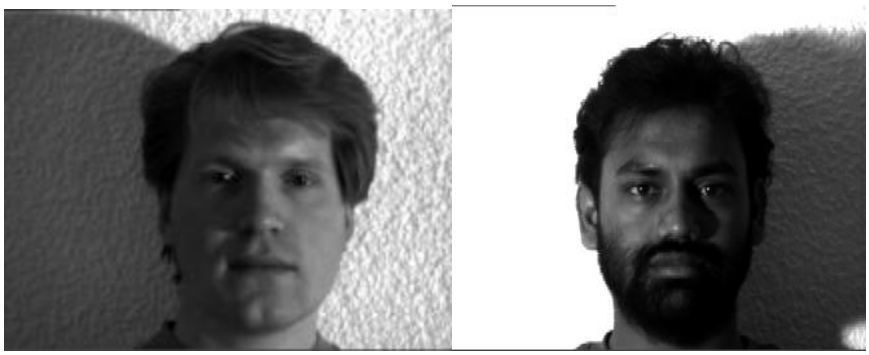

Figure 10: The unilateral lighting of the face

Table 6: The results of the face recognition system in the state of the unilateral lighting to the face

The number of faces tested: 60				
	PCA	LDA	Gabor	Combinational system
Wrong	12	9	2	A
Correct	48	51	58	59
Success percentage	80%	85%	96.66%	98.33%

4.2. Summing up the results

In the last five sections, the obtained results from the different conditions of the environmental tests were evaluated. In this section, the results of different methods will be compared. So in this section, the results of conducted tests are evaluated totally. Table 7 has shown the results.

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Table 7: Summing up the results of the test in the different test environments

The number of faces tested: 360				
	PCA	LDA	Gabor	Combinational system
Wrong	35	27	6	2
Correct	325	333	354	358
Success percentage	90.28%	92.5%	98.33%	99.44%

It should be noted that the results have been obtained based on the images in YALE information bank and under controlled conditions. The Controlled conditions are necessary due to lack of block to find the faces and pre-processed images. So all images in this information bank are in the horizontal state, the different gestures or the images of the profile haven't been presented in this test environment of the face recognition.

Conclusion

The results show that the changes in lighting, especially dotting or spotting the image or the unilateral lighting conditions are the most important factors which affecting PDA and LDA algorithms. Gabor algorithm had the best results of six states of seen errors among 360 different states of the test. These errors were made because of the noisy images and the reaction of these methods to the rapid variations of the face lighting states. The low speed and the high process value are among the seen shortcomings in the Gabor algorithm, some how the time of process for this algorithm is compared with the multiplication of the time of PDA and LDA algorithms. This problem is particularly evident in training the system. PCA and LDA algorithms have an acceptable speed for recognizing the face, generally the speed equation can be considered for the different algorithms as follows.

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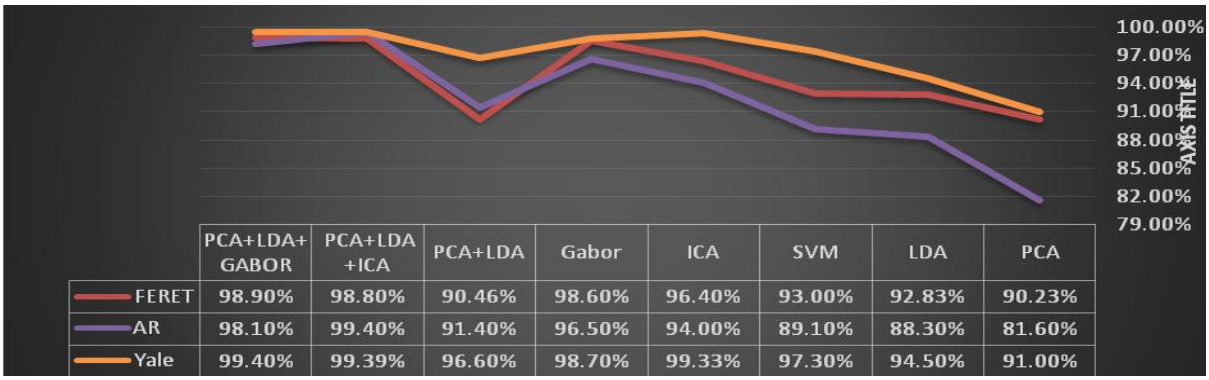
Equation (1) $PCA > LDA >> Gabor$

The results of the combined systems are dependent highly on training the neural networks and the convergence of these networks for reducing the output errors, so the better results will be obtained by suitable training of the network. The process of training neural networks is repeated several times during the test. This repetition causes to repeat the results in the test conditions.

Table 8: The increase Percentage of the accuracy in the combined system in comparison with individual algorithms

PCA	LDA	Gabor
9.16%	6.94%	1.11%

The evaluation results have been conducted based on the accuracy of the recognition and the obtained results by the algorithms have been presented using the various databases in Figure 9. It should be noted that the given values are the average of the data. Regarding Figure 9, the combined proposed algorithm of the paper i.e. PCA + LDA + Gabor has better results than other algorithms.



	PCA+LDA+ GABOR	PCA+LDA +ICA	PCA+LDA	Gabor	ICA	SVM	LDA	PCA
FERET	98.90%	98.80%	90.46%	98.60%	96.40%	93.00%	92.83%	90.23%
AR	98.10%	99.40%	91.40%	96.50%	94.00%	89.10%	88.30%	81.60%
Yale	99.40%	99.39%	96.60%	98.70%	99.33%	97.30%	94.50%	91.00%

Figure 9: The results of evaluating algorithms in the different databases

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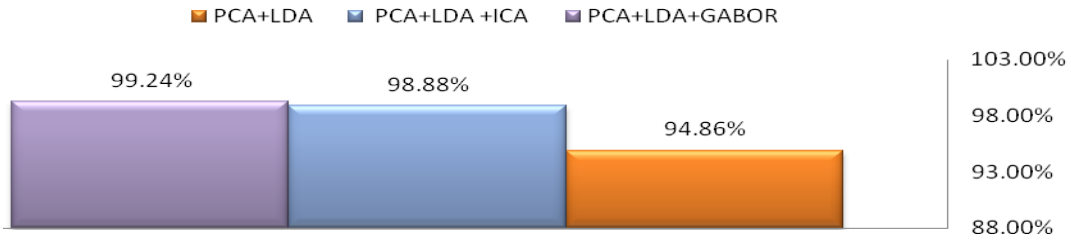

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