Face Recognition Technique Based On Artificial Neural Network and Principal Component Analysis

Alaa Hussein Al-Hamami and Noor Hamadi Batty
Amman Arab University, Amman 11953, Jordan
Alaa_hamami@yahoo.com

***Abstract*- This research will use Data Mining (DM) algorithm and Principle Component Analysis (PCA) to extract features from images by using Eigen Vector function. Data mining and PCA are the process of finding correlations or patterns in the images then take these image features to Neural Network for training and testing. Image pre-processing is required prior to presenting the training or testing images to the neural network. This process is to reduce the computational cost and providing a faster recognition system while presenting the neural network with sufficient data representation of each face to achieve meaningful learning. At the end, the attained outcomes from the tests will be demonstrated and analyzed, which these tests are based on colored pictures with one face background. A comparison will be done to relate works with proposed algorithm to accomplish good precision.**

Keywords--Data Mining; Principle Component Analysis; Eigen; Face Recognition; and Neural Network.

I. INTRODUCTION

The face recognition system is the advanced method of card access; in this the person is identified just by means of various other resources like the image is getting stored in the database. By using Data Mining software and that is get functioning in case of other resources and found original image get matched. Data mining and PCA are the process of finding correlations or patterns among dozens of fields in large relational databases. In data mining, PCA are useful for analyzing and predicting customer behavior [1].

The identification of the person is to find that the nodes are in which the patches are identified and processed to be that it will matches each and every node present in the face that are recognized and that is identified and compared with the model which is present in the nodes that can be resembled and matches and finally the process gets good functions [2]. Facial feature dots are usually related to as facial significant dots for example the curves of the eyes, curves of the eyebrows, bends and external mid dots of the lips, bends of the nostrils, top of the nose, and the top of the chin. Recognition of facial characteristic points is regularly the first stage in computer vision appliances for example face recognition, facial appearance detection, faces following and lip reading. For instance, localization of facial points is the first stage of "Active Shape and Active Appearance Models algorithms" [3].

II. PROBLEM STATEMENT

Data mining in addition to PCA find out inherent knowledge in a dataset depends on several methods, which could be executed separately or together. These methods try to discover information, to illustrate their

texts and take out the more significant data. In this research, one sub-problem that is related to the face detection will be presented. The major trouble that is needed to overcome is to recognize pixels in the image [4]. So in order to get high performance in addition to accepted accuracy during image detection, MATLAB software techniques is used in this research for this purpose, thus the need to simulate recognition artificially in our attempts to create intelligent autonomous machines. The training of the database and testing images will be done using Neural Network. The suggested techniques will supply a way to enhance the efficiency of the detection system of the main face as well as will offer more accurate results that are should be very close to the expected results [5].

III. MAIN METHODOLOGY

Two main systems will be studied; Fig. 1 illustrates the first one which contains Data mining (PCA+N.N).

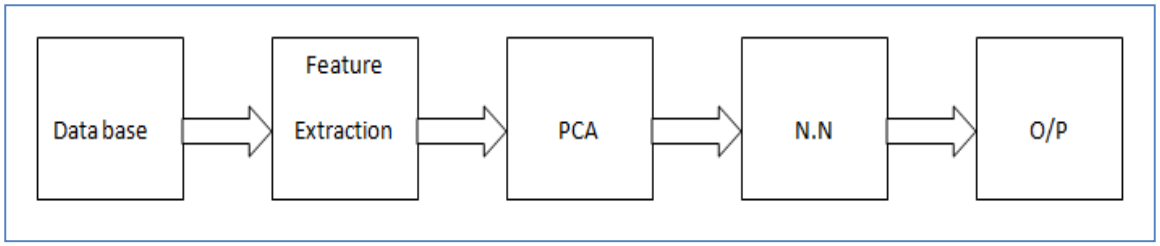


Fig. 1. System with PCA

And the other system has shown in Fig. 2. This system doesn't contain the PCA block.

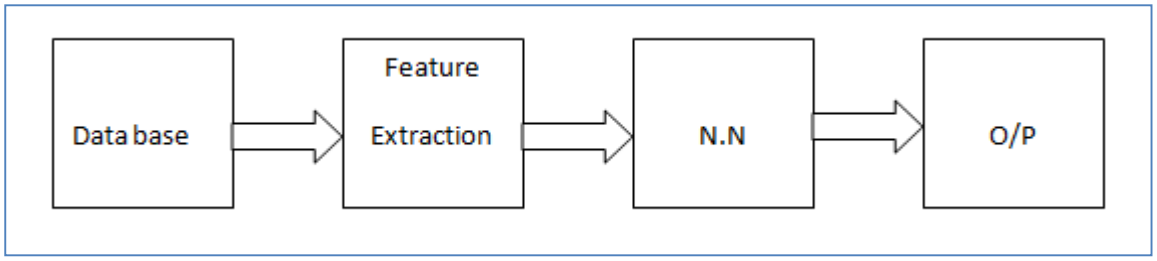


Fig. 2. System without PCA

IV. DATA BASE

The database which was used in the system is the ORL database. ORL Database includes a set of face images taken a mid-April 1992 and April 1994. There are ten dissimilar images of every of 40 separate topics. For a few topics, the images were taken at dissimilar instances, changing the lighting, facial appearances (closed /open eyes, not smiling / smiling) and facial features (glasses / no glasses). Every image was taken alongside dark uniform surroundings with the topics in a straight, forward location. The dimension of every image is 92x112 pixels, with 256 grey levels per pixel. The images are prearranged in 40 directories (one for every topic), which have names of the type sX, where X points to the topic digit (amid 1 and 40). In all of these directories, there are ten dissimilar images of that topic, which have names of the type Y.pgm, where Y is the image digit for that topic (amid 1 and 10) [6].

V. FEATURE EXTRACTION

The job of the feature extraction and assortment techniques is to get the majority applicable data from the original data and symbolize that data in a lower dimensionality space. The aim is to choose,

amongst all the obtainable characteristics, those that will execute better. The following 15 features will be introduced in the form of distance [7]. These features are: (1) Width of nose, (2) Left eye to right eye, (3) Width of mouth, (4) Left eye to left side of nose, (5) Right eye to right side of nose, (6) Left side of nose to right side of mouth, (7) Right side of nose to left side of mouth, (8) Left eye to middle of nose, (9) Right eye to middle of nose, (10) Vertical distance from mouth to nose, (11) Horizontal distance from left edge of face to left side of nose, (12) Horizontal distance from right edge of face to right side of nose, (13) Horizontal distance from left edge of face to left side of mouth, (14) Horizontal distance from right edge of face to right side of mouth, and (15) Vertical distance from eye to nose.

The value of feature vector characterizes absolute space amid feature points. For example, let the left eye (X_1, Y_1) and middle of nose (X_2, Y_2). Then, their absolute distance is computed by Eq. 1:

$$(8) = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2}. \quad ..... \quad (1)$$

A high-quality characteristic extraction will raise the performance of face recognition scheme.

VI. PCA-IMMUNE SYSTEM

The algorithm utilized for PCA is as follows:

(i) Obtain a first set of M face images (the teaching set) and compute the Eigen-faces from the teaching set, remaining only M' Eigen-faces that match to the highest Eigen-value.

(ii) Compute the matching allocation in M'-dimensional weight space for every identified individual, and compute a set of weights based on the input image.

(iii) Categorize the weight model as either identified person or as unidentified, consistent with its space to the neighboring weight vector of an identified person.

VII. NEURAL NETWORK

The Algorithm for Face recognition by neural classifier is as follows:

1. Pre-processing step –Images are made zero-mean and unit-variance.

2. Dimensionality decrease step: PCA - Input data is summarized to a lower dimension to facilitate classification.

3. Categorization step - The reduced vectors from PCA are applied to train back propagation neural network classifier to get the recognized image.

An artificial neural network is a nonlinear and adaptive arithmetical module enthused by the working of a human brain. It consists of simple neuron factors operating in parallel and communicating with each other during weighted interconnections [8].

The Multi-Layer Perceptions (MLP) refers to the network consisting of a set of sensory units (source nodes) that comprise the input layer, one or additional concealed layers of calculation nodes, and an output layer of calculation nodes. The input signal broadcasts during the network in a head way, from left to right and on a layer-by-layer basis.

Training a Net: The incentive for applying back propagation net is to attain equilibrium amid memorization and generality; it is not of necessity beneficial to go on teaching waiting the error arrives at a smallest amount value. The weight alterations are based on the teaching patterns. As long as error the for corroboration decreases training continues. When the error starts to rise, the

net is starting to remember the teaching patterns. At this point teaching is finished.

In this paper Face Recognition system model is constructed using MATLAB software and using Feature Extraction and Neural Networks, in order to satisfy the main aim of this project, analyze the main concepts and the performance of Face Recognition system to obtain results and compare them with PCA system.

1. Load database that contains different images as training and tasting.
2. Save training images and testing images in different variables.
3. Apply training images of NN to get main learn using back propagation method in order to get optimum weights at specific mean square error.
4. Apply PCA for classification to enhance training section.
5. Apply eigen vector method with EOD to get main features and to eliminate unwanted pixels.
6. Apply recognition rate measurement for NN with and without PCA.

VIII. SYSTEM IMPLEMENTATION

As we mentioned previously, there will be two systems as the following.

A. System without using PCA

To obtain the results many steps must be performed:

1. Extract the files under MATLAB software.
2. To run the program, Neural Networks and Image processing tool boxes should exists.
3. Then form main file within the command window.

First Step: Database

In this step all database will created automatically by design, and it will be ready to do the next step that is Initialize network.

Second Step: Train Network

Fig. 3 shows the second step of face detection, which is train Network. Also in this step the algorithm and the progress of the face detection are demonstrated.

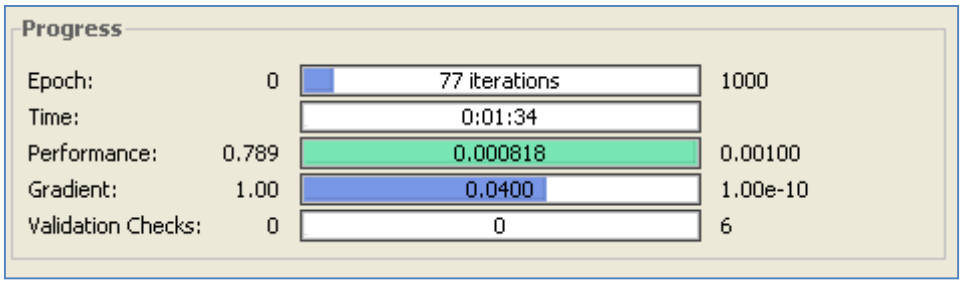


Fig. 3. Train Network Step

Fig. 3 demonstrates the progress of the face recognition algorithm, the performance which desired in this code is equal to 0.00100, in addition to that the gradient is equal to $1.00*e^{-10}$.

Last Step: Test Network

The results of face detection are obtained after this step is completed. In order to perform this step:

1. Select Image Scanning from the menu.
2. Choose one of the images in order to show the result, the program is able to identify faces just concerning [27 18] pixels within the image and this number of pixels was obtained by trial and error it was found that this number offer the optimum solution.
3. A test is done on the data base of the images as Fig. 4.

Fig. 5 illustrates another view for the face.

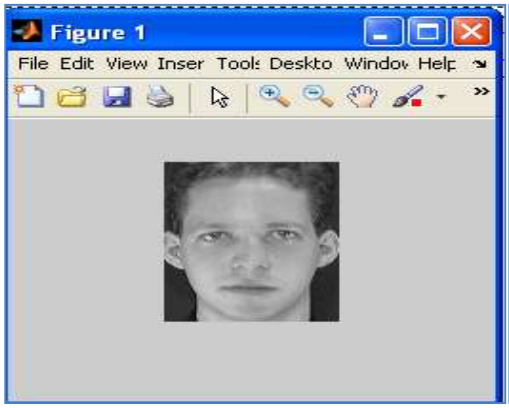
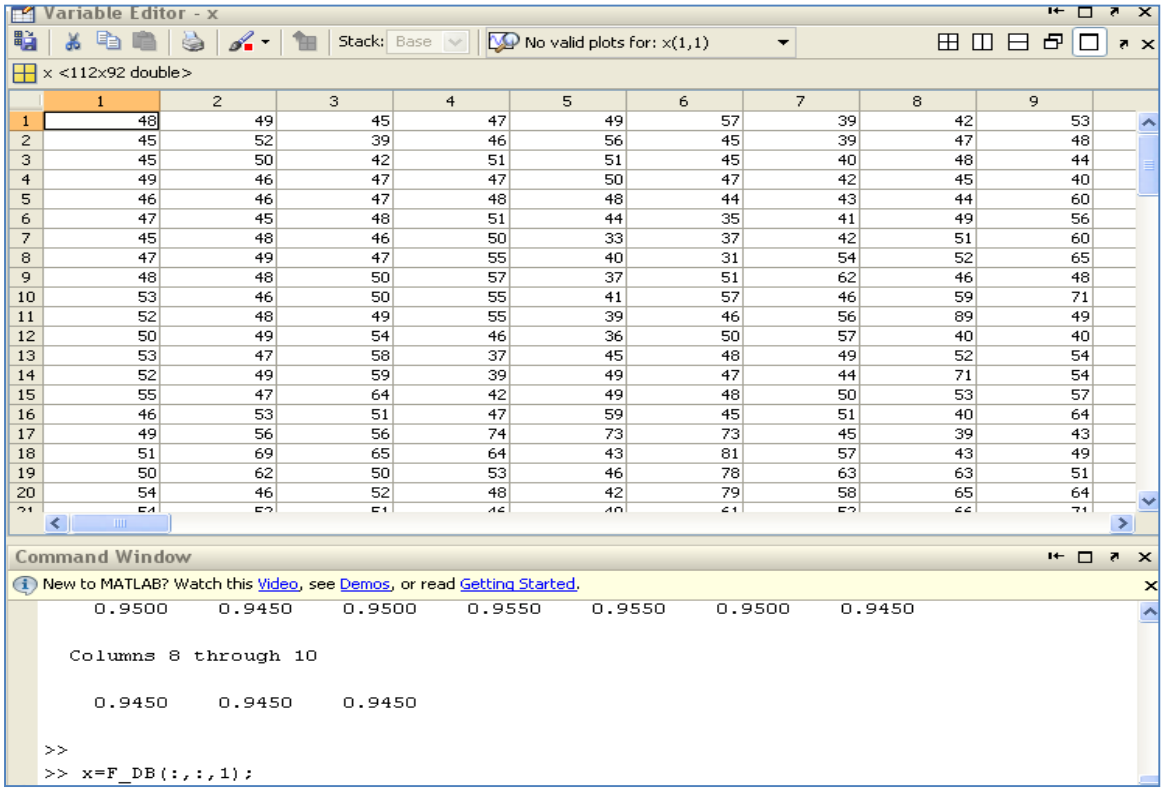


Fig. 4 test 1 for face detection

Fig. 5. the detected face from database

There are two processes done on the data base which are testing and training and for each image there is more than one view saved in the data base, so for the above picture when it was tested another view for the same image was detected through the detection process.

For the first view of the image above, the face data was found by the MATLAB code which means the values of the matrix for the detected image and it was as shown in Fig. 6. The function X= F_DB (:, :, 1) which is shown in the workspace of the MATLAB code characterizes the face data for the first image.



	1	2	3	4	5	6	7	8	9
1	48	49	45	47	49	57	39	42	53
2	45	52	39	46	56	45	39	47	48
3	45	50	42	51	51	45	40	48	44
4	49	46	47	47	50	47	42	45	40
5	46	46	47	48	48	44	43	44	60
6	47	45	48	51	44	35	41	49	56
7	45	48	46	50	33	37	42	51	60
8	47	49	47	55	40	31	54	52	65
9	48	48	50	57	37	51	62	46	48
10	53	46	50	55	41	57	46	59	71
11	52	48	49	55	39	46	56	89	49
12	50	49	54	46	36	50	57	40	40
13	53	47	58	37	45	48	49	52	54
14	52	49	59	39	49	47	44	71	54
15	55	47	64	42	49	48	50	53	57
16	46	53	51	47	59	45	51	40	64
17	49	56	56	74	73	73	45	39	43
18	51	69	65	64	43	81	57	43	49
19	50	62	50	53	46	78	63	63	51
20	54	46	52	48	42	79	58	65	64

Fig. 6. face data for the first view

Another test is done on another face, and the result was as in Fig. 7 and Fig. 8:

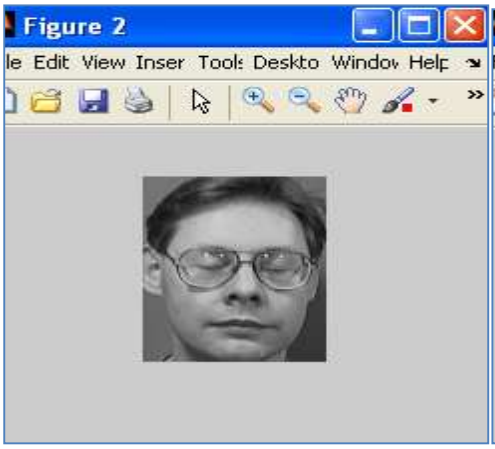


Fig. 7. Another test for face recognition

Fig. 8. The detected face from database

A third test is performed on the set of images as seen in Fig. 9 and Fig. 10:

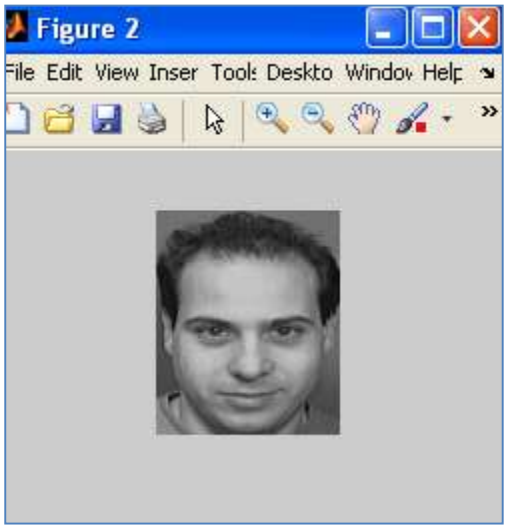


Fig. 9. Third test for face recognition

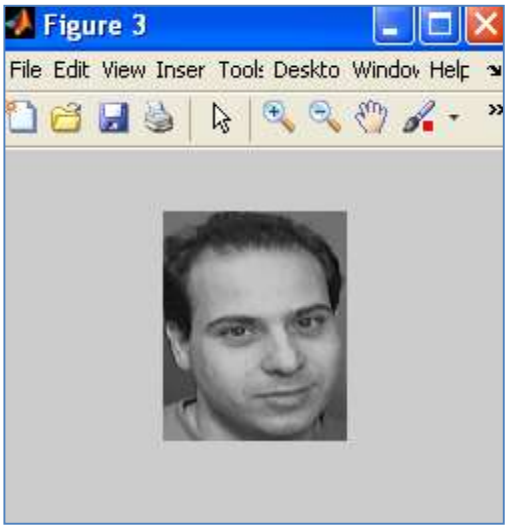


Fig. 10 the detected face from database

B. System with PCA

A pattern recognition method called PCA was developed using MATLAB as the best pattern recognition algorithm. In addition, PCA algorithm is based on categorizing the image dataset into classes, minimize the in-class distance and maximize the between-class distance. As a result, PCA will provide higher performance than the other pattern recognition methods. ORL database was exploited to test the proposed algorithm and compare it with other previous algorithms. ORL database involves images of forty persons (classes), ten sample images per person of different expressions. On the other hand, all of the images of both databases are of size 112 * 92, with 256 grey levels per pixel. The files are in PGM format. The images are organized in 40 directories (one for each subject), which have names of the form sX, where X indicates the subject number (between 1 and 40). In each of these directories, there are ten different images of that subject, which have names of the form Y.pgm, where Y is the image number for that subject (between 1 and 10). The same steps are done for the system with PCA in MATLAB; on the other hand the results show that there is a difference in the recognition rate since the recognition rate for the system with PCA is larger than that without PCA. Fig. 11 presents the recognition rate difference between PCA system and system without PCA.

Fig. 11. Recognition Rate difference

The horizontal axis represents the iterations and the vertical one represents the recognition rate. Related to the Recognition Rate (RR) curve, it shows that the RR with PCA enhance the overall system by 0.02 related to the main database, that means the accuracy increase by 0.02 which provides more accuracy and high recognition using PCA.

Table 1 : Recognition Rate difference

RR without PCA	RR with PCA	Enhancement
0.9500	0.9750	0.025%
0.9450	0.9650	0.02%
0.9500	0.9700	0.02%
0.9550	0.9700	0.015%
0.9500	0.9700	0.02%
0.9450	0.9700	0.025%
0.9450	0.9650	0.02%
0.9450	0.9650	0.02%
0.9450	0.9650	0.02%
0.9450	0.9650	0.02%

IX. DISCUSSION

A comparison between the implemented approach which is face recognition using PCA and other approaches like, K-means algorithm and face recognition using Fuzzy moments method will be held. The suggested algorithm is founded on sole image for each person, in this technique, primary input and database images are divided into 4 partitions. Then moment characteristic vectors of an exact order for every image are removed. Following this step, space gauge is utilized for discovering lowest distance amid input vector and other vectors and the associated person is identified. After that order comparator is executed in the direction of raising the accurateness. For an input trial image, the suggested technique is realized for three sorts of moments which are: Geometric, Legendre and Complex unconnectedly and lastly a fuzzy mixture of these three states is utilized for last conclusion.

X. EVALUATION

Fuzzy moment's method outcomes show 96%, 86% and 84% accurateness for ethnic, FERET and AR correspondingly. On the other hand, for K-means method the allocation of distances of images from their barycentre attained throughout the 10% cross-validation phase has been utilized to notice intruders, that is to say, images of people or things that are not signified in the preparation set. This method seems to act quite well to sense intruders. But when comparing PCA technique results with K-means and Fuzzy moments method the PCA outcomes show butter accuracy as well as superior recognition rates, on the other hand the results present lower space dimension. Table 2 has shown the comparison between K-means method, Fuzzy moments and PCA Proposed Technique.

Table 2 : Comparison between K-means methods, PCA, and Fuzzy moments methods

K-means methods	PCA proposed technique	Fuzzy moments
10% cross-validation phase	95.5%	96%, 86% and 84% for ethnic, FERET and AR

Related to the Recognition Rate (RR) curve, it shows that the RR with PCA enhance the overall system by 2% related to the main database, that means the accuracy which is calculated by dividing the recognition rate value by the maximum value which is 100 and then multiplying the result with 100% increase by 2% which provides more accuracy and high recognition using PCA. The recognition rate is calculated by dividing the number of recognized images by the number of testing images which are 10 tests in this research.

Table 3 shows the recognition rate before and after using the proposed PCA technique.

Table 3 Recognition Rate Comparison

RR Without PCA	**RR With PCA**	**Enhancement**
95%	97.5%	2.5%
94.5%	96.5%	2.0%
95%	97%	2.0%
95.5%	97%	1.5%
95%	97%	2.0%
94.5%	97%	2.5%
94.5%	96.5%	2.0%
94.5%	96.5%	2.0%
94.5%	96.5%	2.0%
94.5%	96.5%	2.0%

IIX. Conclusions

In this paper, the process in face recognition based on using both the neural network with and without PCA technique in combination with the Even-Odd Decomposition (EOD) technique is proposed. This process starts with dividing a known face images dataset into two databases; training and test databases, applying the even odd decomposition technique on each database, evaluating the row-row and column-column covariance matrices of even and odd parts, applying PCA technique, finding both the in-class and between-class scatter matrices of each part and combining the scatter matrices of each part in order to find the projection matrices, compute the even-odd Eigen vectors and extract the feature matrix based on Eigen value and Eigen vector. The developed algorithm can be used in order overcome the main restrictions of using the traditional PCA algorithm, which are: the dependency on a one-dimensional vector only, the

need for converting the image matrices into vectors and the huge dimensions of the resultant image matrices. Results show that there is a match between both the recognition rate and the success values of the algorithm and the resultant maximum recognition rate is 95.5%. In addition, both the Eigen values and the success values are directly related to the number of sample classes, in which when the number of sample classes increases, both the accuracy and recognition rate of the system are enhanced.

REFERENCES

[1] W. Moudani, A. Shahin, F. Chakik, A.R. Sayed and F. Mora-Camino: An Efficient Approach for Image Recognition using Data Mining. International Journal on Computer Science and Engineering (IJCSE). Vol. **3, No. 1,** 2006, p. 55- 68.

[2] I.V. Sridhar & Murali Krishna: Face Recognition using Techebichef Moments. International Journal of Information & Network Security (IJINS). Vol. 1, No. 4, 2012, p. 243-254.

[3] J. Harguess and J. Aggarwal: Is There a Connection Between Face Symmetry and Face Recognition? *Computer Vision and Pattern Recognition Workshops (CVPRW),* 2011 IEEE Computer Society Conference, 2011, p. 66 – 73.

[4] R. Amit. Devale. Face Photo-Sketch Synthesis and Recognition. International Journal of Applied Information Systems. Vol. 1, No. 6, 2012, p. 46-52. Published by Foundation of Computer Science, New York, USA.

[5] O. Allaf. Improving the Performance of Back Propagation Neural Network Algorithm for Image Compression/Decompression System. Journal of Computer Science. Vol. 6, No. 11, 2010.

[6] A. Jain, B. Klare and U. Park. Face Recognition: Some Challenges in Forensics. IEEE International Conference, 2011.

[7] R. Sudhir. A Survey on Image Mining Techniques: Theory and Applications. Computer Engineering and Intelligent Systems. Vol. **2, No.6, 2011,** p. 44-52.

[8] R. Akbari and S. Mozaffari. Fuzzy Moments Method for Face Recognition in an Ethnic Database. International Journal of Signal Processing, Image Processing and Pattern Recognition, 2012, vol.5, no.1.

[9] N. Mittal and E. Walia: Face Recognition Using Improved Fast PCA Algorithm. CISP ’08 Proceedings of the 2008 congress on Image and Signal Processing. Vol. 1, 2008, P. 554-558.