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# Real Time Face Recognition in Video Using Linear Discriminate Analysis and Local Binary Patterns

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## ABSTRACT

The need for robust recognition system in applications of surveillance and biometrics is increasing with the advancements in technology. The conventional method of passwords and pin numbers can be easily hacked,a so these are being rapidly replaced by more secure and reliable biometric methods. This paper produces a new real-time surveillance system in video which makes use of face characteristics of the user for correct identification. The face is first detected using Viola-Jones algorithm, then a hybrid algorithms were used to extract the features and determine the faces linear discriminate analysis and local binary patterns. The proposed approach tested and gives efficient results when compared with other previous approach.

**Keywords:** face recognition, fisherfaces, LDA, LBP.

## تمييز الوجوه بالفيديو بالوقت الحقيقي باستخدام تحليل التمييز الخطي والانماط الثنائية المحلية

**الخلاصة**

ان الحاجة لنظام تمييز قوي في تطبيقات المراقبة والاحصائيات البيولوجية قد تزايدت مع التقدم التكنولوجي. الطرق التقليدية للرموز السرية وأرقام تحديد الهوية الشخصية يمكن اختراقها بسهولة، لذلك فهي تستبدل سريعا بطرق بيولوجيةأكثر امانا وموثوقية حيث تستخدم خصائص الوجه لتحديد هوية المستخدم. في هذا النظام تم استخدام خوارزمية فيولا جونز لتحديد الوجه وتم دمج خوارزمية تحليل التمييز الخطي وخوارزمية الأنماط الثنائية المحلية لاستخلاص الخصائص والتعرف على الوجه. تم اختبار الطريقة المقترحة وقد أعطت نتائج كفوءة مقارنة بالطرق السابقة.

## INTRODUCTION

The people are identified by their faces all the time. Human brain is capable of doing this job highly efficiently and in a matter of few seconds. For the past few decades, there has been a lot of research being done to duplicate the results of human brain in the field of face recognition[1].

Face recognition has a wide range of applications, including law enforcement, civil applications, and surveillance systems. Face recognition applications have also beenextended to smart home systems where the recognition of the human face and expression is used for better interactive communications between human and machines [2].

## Related Work

Hyun-Chul Choi1 et al. (2006) [3] suggested an approach for real-time recognition of facial expression which utilizes the Active Appearance Model (AAM) with a second order minimization and a neural network. The second order minimization provides the capability of accurate convergence with a tiny decrease of frame rate to AAM. And the effectively extracted facial design with AAM prevents the recognition of facial expression from going through a large error.Mario i. chacon m. et al.(2007)[4] proposed an approach aimed to model a fuzzy face recognition system, proposed face feature lines, new features are added to the features vector used to create the pattern recognition system.In addition to the face characteristic outlines, the feature vector brings together eigenvectors of the face image captured with the karhunen-loeve transformation. HananeBenrachid et al (2011) [5] proposed a technique which deals with the non-trivial problem of human face recognition. This technique is based on two main steps. The first step is an unsupervised fuzzy learning algorithm, which detects the classes supposed present in the learning database and provides a prototype or representative for each detected class. The second one is an artificial neural network which uses these prototypes in order to determine the separating boundaries of classes in the data space.EkhlasFalih Nasser(2012)[6] proposed a technique for human face recognition. Two tests are executed for theimage. The first test depends on splitting the image vertically into two parts (left partand right part) for evaluating the seven moments for each part to find similarity anddifference between these parts. The second test depend on taking the image in differentcases such as (image rotation and turn the angle of photo with different values) ,extract the characteristics( such as eyes, nose, and mouth) of these images in thesecases ,then compute the seven moments for these characteristics and then finding thesimilarity and difference between these characteristics.Swarupkumar and sukadevmeher (2013) [7] suggested and examined a high-performance face recognition algorithm using conventional principle component analysis (PCA) and two dimensional principle component analysis (2DPCA).the researchers tried to assign different weight to the only very few non zero eigenvalues related to Eigen vectors which are considered as non-trivial principle component for classification. Finally face recognition stage is performed by k-nearest distance criteria.

## Face Recognition System

A face recognition system generally consists of four modules as depicted in Figure(1): **face localization, normalization, feature extraction,** and **matching**, where localization and normalization (face detection and alignment) are processing steps before face recognition (facial feature extraction and matching) is performed [8].

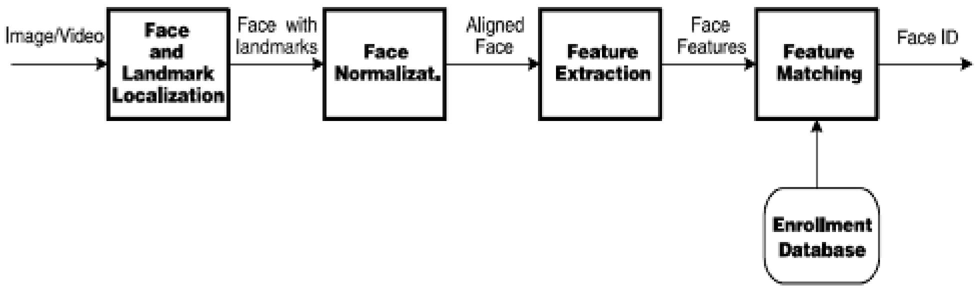



**Figure (1) Configuration of generic face recognition system [1]**

**Face localization (detection)** segments the face area from the background. In the case of video, the detected faces may need to be tracked across multiple frames using a face tracking component. While face detection provides a coarse estimate of the location and scale of the face, face land marking localizes facial landmarks (e.g., eyes, nose, mouth, and facial outline). This may be accomplished by a land marking module or face alignment module.

**Face normalization** is performed to normalize the face geometrically and photo-metrically. This is necessary because state-of-the-art recognition methods are expected to recognize face images with varying pose and illumination. The geometrical normalization process transforms the face into a standard frame by face cropping. Warping or morphing may be used for more elaborate geometricnormalization. The photometric normalization process normalizes the face based on properties such as illumination and gray scale.

**Face feature extraction** is performed on the normalized face to extract salientinformation that is useful for distinguishing faces of different persons and is robustwith respect to the geometric and photometric variations. The extracted face featuresare used for face matching.

In **face matching** the extracted features from the input face are matched againstone or many of the enrolled faces in the database. The matcher outputs 'yes' or'no' for 1:1 verification; for 1:N identification, the output is the identity of the inputface when the top match is found with sufficient confidence or unknown whenthe tip match score is below a threshold. The main challenge in this stage of facerecognition is to find a suitable similarity metric for comparing facial features[9].

## Fishers' Linear Discriminant Algorithm LDA

Fisher's linear discriminant is a classification method that projects high-dimensional data onto a line and performs classification in this one-dimensional space. …( 1 ) maximizes the distance between the means of the two classes while [illegible] variance within each class. This defines the Fisher criterion, which is maximized over all linear projections w[10]:

$J(w)=|m_1+m_2|^2/ S_1^2 + S_2^2$

Where
$m$ represents a mean, $S^2$ represents a variance, and the subscripts denote the two classes. In signal theory, this criterion is also known as the signal-to-interference ratio. Maximizing this criterion yields a closed form solution that involves the inverse of a covariance-like matrix. This method has strong parallels to linear perceptron. The threshold is learned by optimizing a cost function on the training set[10].

**Local Binary PatternsLBP**

The local binary pattern (LBP) is a non-parametric operator which describes the local spatial structure of an image. Ojala et al. first introduced this operator and showed its high discriminative power for texture classification. At a given pixel position ($x_c$; $y_c$), LBP is defined as an ordered set of binary comparisons of pixel intensities between the center pixel and its eight surrounding pixels Figure(2). The decimal form of the resulting 8-bit word (LBP code) can be expressed as follows[11][12]:

$$LBP(x_c,y_c) = \sum_{n=0}^{7} s(i_n - i_c)2^n \quad \ldots(2)$$

where
$i_c$corresponds to the grey value of the center pixel ($x_c$; $y_c$),
$i_n$to the grey values of the 8 surrounding pixels, and function $s(x)$ is defined as:

$$s(x) = \begin{cases} 1 & \text{if} \quad x \geq 0 \\ 0 & \text{if} \quad x < 0 \end{cases}.$$

By definition, the LBP operator is unaffected by any monotonic gray-scale transformation which preserves the pixel intensity order in a local neighborhood. Note that each bit of the LBP code has the same significance level and that two successive bit values may have a totally different meaning. Actually, The LBP code may be interpreted as a kernel structure index.

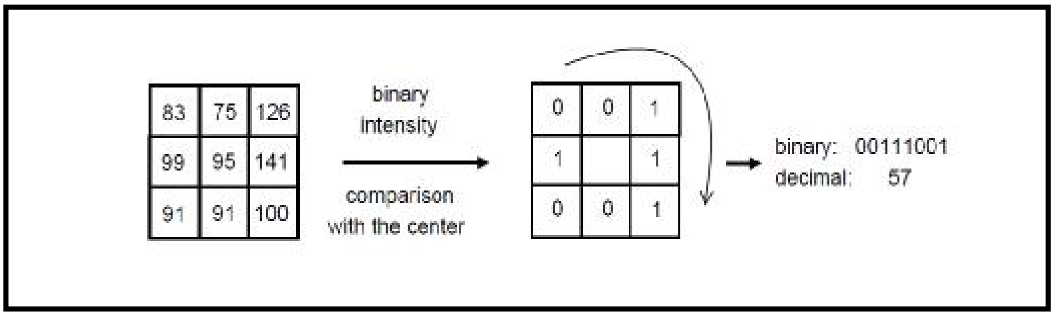
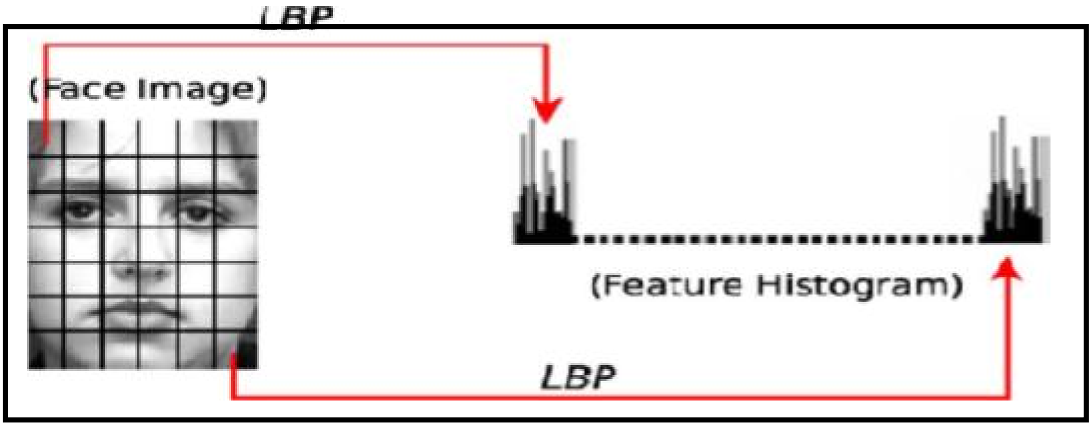



**Figure (2) The LBP operator[11]**

After scanning a facial expression image by LBP operator, the LBP coding image of original image is got.Then the texture feature of image can be described by counting the facial expression image histogram. The process of LBP feature extraction is shown on Figure(3).




**Figure(3)LBP feature extraction [13]**

The LBP coding image includes local micro-mode information of the original image, such as edge, featurepoints and spot, etc. So the local texture feature of a facialexpression image can be described by a histogram which isformed by LBP codes[13]

**Proposed System**

The idea of the proposed systemdepends on the protection of important location by using a static camera put in a place leading to the location to be protected**,** the camera is connected to computer system and captures real time video imagery and passes it to proposed system and then the following steps will be performed ***:***

**Step1: Capture Frame**

In this step the dataset of face(s) has been captured using CAM device. The CAM device need to initialize ID of device connected to PC, and specify the dimension (height and width) of captured frame.

**Step2:Convert Current Color Frame to Grayscale**

Most of the benefits of converting a color image to grayscale domain is that to have less data which leads to fast processing during others phases (feature extraction and training phase),In the proposed work, the luminance method is used to convert colour image to grayscale as explain in equation (3)as shown in figure (4):

$$\text{Grayscale}(i,j) = R * 21 + G * 0.71 + B * 0.07 \qquad \dots(3)$$

where

R=read, G=green, B =blue

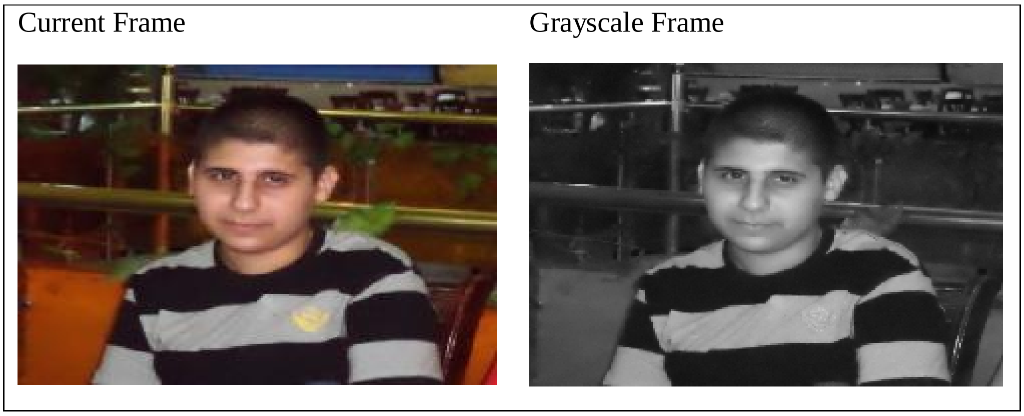



**Figure (4) grayscaling step**

**Step 3:Detecting Faces**

After scaling and gray-scaling the frame, Viola-Jones algorithm were used to detect faces in the frame and at the same time determine their positions as shown in figure (5):

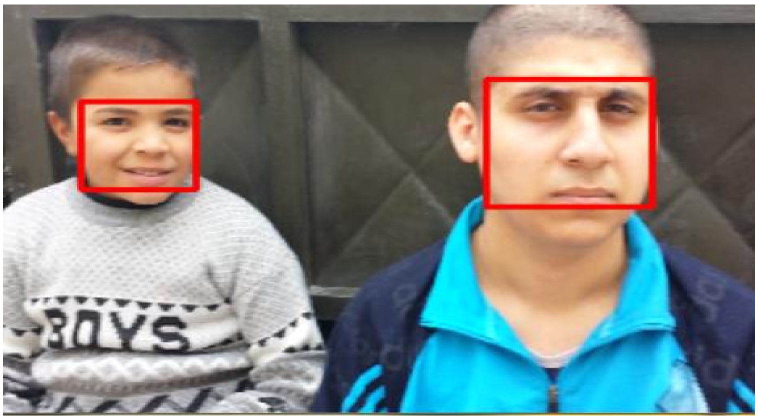


**Figure (5) face detected process**

**Step 4:Feature Extraction**

The idea of the proposed approach is to use LDA to extract the global grayscale feature of the whole facial expression image, but it is sensitive to lighting environment. LBP can extract the local texture feature of facial expression image. LBP helps to extract the distinctions of changes among different kinds of facial expression, but ignores the global information of the whole facial expression image. Therefore, two methods, LBP and LDA are integrated in this paper for a more comprehensive and robust face recognition bycalculate LBP code based on the input face detected and the fisherfaces, figure (6) shows the output of featureextraction step:

**Figure(6) face detected (left) ,related feature extraction face (right)**

**Step 5:The face recognition process**

Calculate Euclidian distance between two or more point of the features of test face detected and training set faces images , The Euclidean distance between two weight vectors d(i,j) provides a measure ofsimilaritybetween the corresponding images i and j ,wherei is the testing face and j is the training face.The Euclidean distance is referred to the closest distance between two or more pointsas shown in figure (7).

$$d(A,B)=\sqrt{\sum_{i=1}^{D}(a_i-b_i)^2}=\|A-B\| \qquad \ldots(4)$$

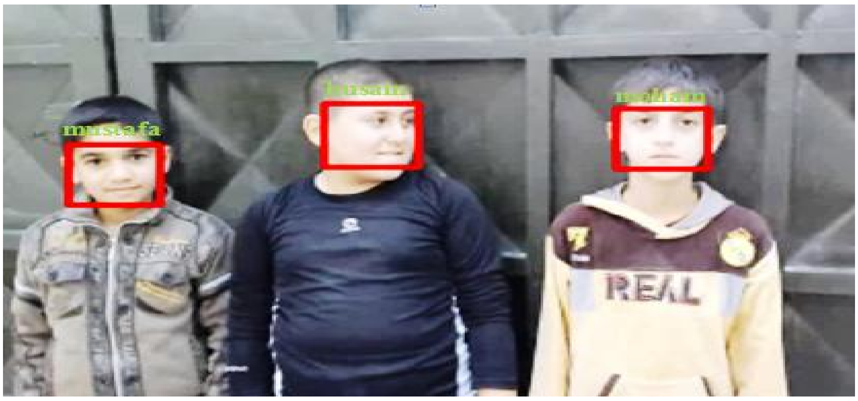



**Figure (7) face recognition step**

**Training Datasets**

In the proposed work the dataset has been prepared through real-time. The dataset contains pictures of face belonging to (5) persons, each person has (5) samples.The images are stored in the JPG file format, the total of the samples for whole system (25). The samples has different appearance such as (lightness, zoom, viewpoint, and expressions) for each person as shown in figure (8). In addition to that, these samples have been captured using WEB-CAM considered as processing in real-time


**Figure (8) samples of captured faces**

The face recognition system in this paper is design as Figure(9).

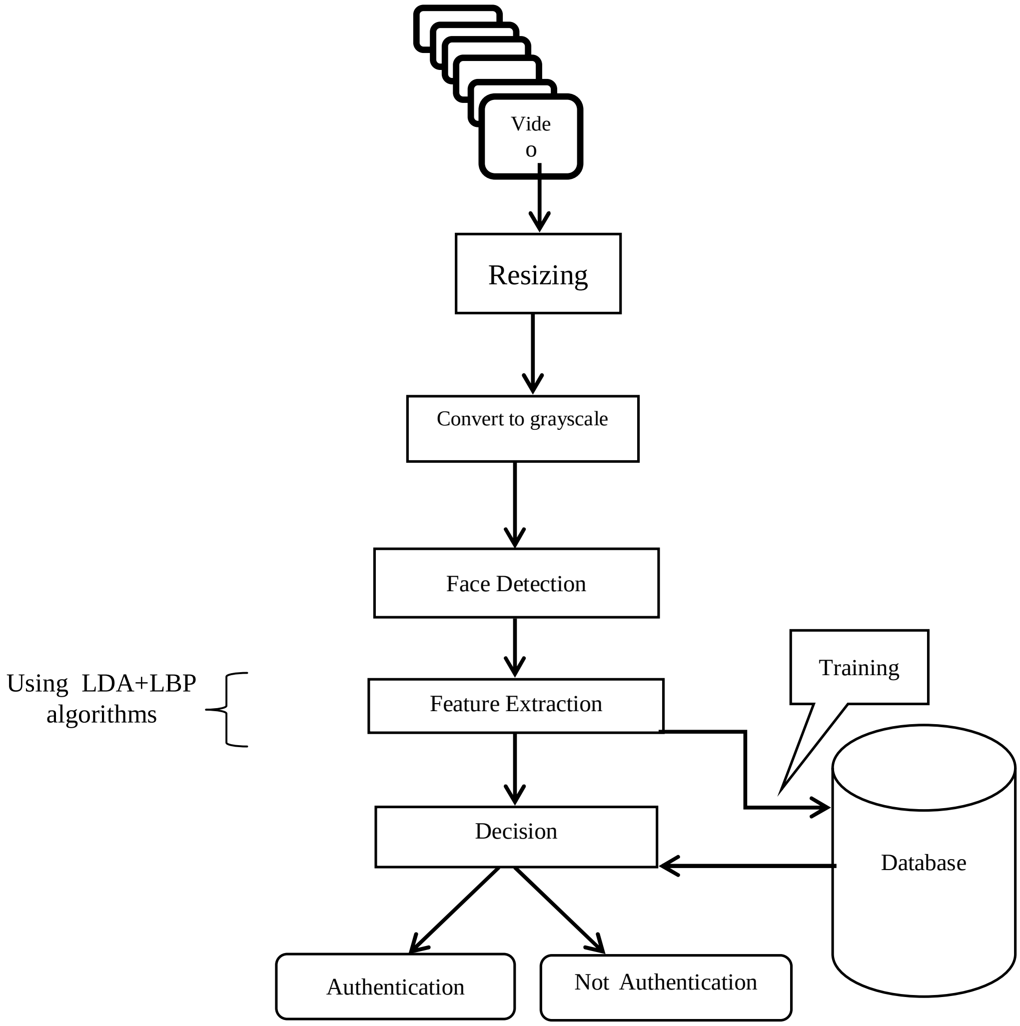



**Figure (9) Proposed system diagram**

**Experiment Results**

The system proposed is a real-time system. Itrecognizes multiple faces in each framefrom input video stream through a web camera.The dataset has been prepared in number of samples for each person with his/her name as label.The results of testing the performance of the proposed system are shown in figure (10) and (11)which shows the recognition rate and error rate.

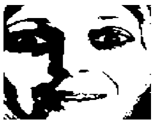
| Sample Test | Match | PSNR | MSE |
|---|---|---|---|
| |  | 50.363306709742320 | 0.598066793736678 |
| |  | 58.562647122472015 | 0.090534821282177 |
|  |  | 54.200591670271870 | 0.247184476963437 |
| |  | 55.150547859075100 | 0.198621187899656 |
| |  | 53.278712438879985 | 0.305639244138383 |

**Figure (10) compute the Fidelity Criteria(MSE,PSNR) of the proposed system**

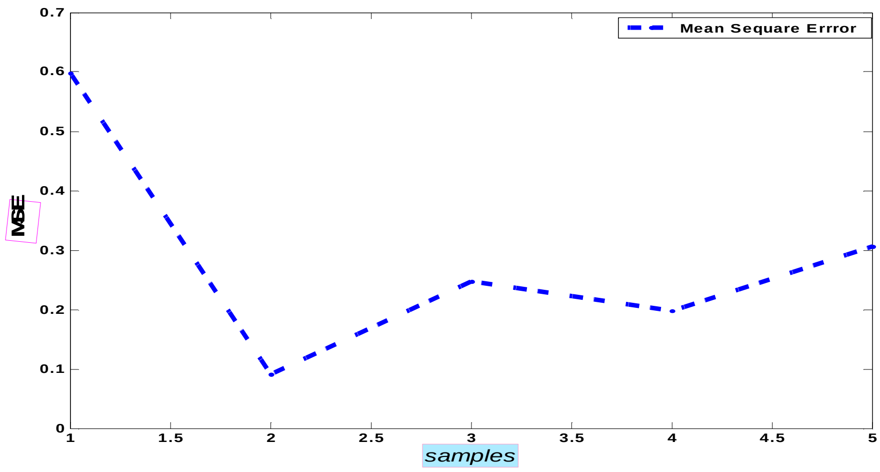



**Figure (11) test of five samples**

**Table (1) Results for proposed system**

| No. of faces in each frame | Recognition rate (in %) | Error rate (in %) |
|---|---|---|
| 1 | 97.34 | 2.36 |
| 2 | 97.22 | 2.65 |
| 3 | 91.12 | 3.02 |
| 4 | 91.11 | 3.01 |
| 5 | 91.10 | 3.2 |

## CONCLUSION

Most researches detect more than oneface in the image without recognize them, inthis paper presenta hybrid LDA and LBP method to detect and recognize many face in real time. In LDA approach, the whole facial image is taken as a feature vector where as in the LBP approach, a sum of local texture descriptors over the entire facial image is taken as the feature vector.The LBP approach provides better tolerance to monotonic gray-scale changes. It has also proved to give better computational efficiency. Another advantage of LBP is that no gray-scale normalization is needed prior to applying the LBP operator to the face image.

## REFERENCES

[1]. Stan Z. Li , Anil K. Jain ,"Handbook of Face Recognition",Second Edition,Springer,2011.

[2]. S. Z. Li and A. K. Jain (eds.)."Handbook of Face Recognition". Springer Verlag,Secaucus, NJ, 2005.

[3] Hyun-Chul Choi and Se-Young Oh,"Realtime Facial Expression Recognition using Active Appearance Model and Multilayer Perceptron ",SICE-ICASE International Joint Conference, 2006.

[4] Mario I. Chacon M.,Pablo Rivas P., and Graciela Ramirez A., "A Fuzzy Clustering Approach for Face Recognition Based on Face Feature Lines and Eigenvectors",Advance Online Publication,2007.

[5] HananeBenrachid and AbdelazizBouroumi,"Unsupervised Classification and Recognition of Human Face Images ", Applied Mathematical Sciences, Vol. 5, 2011.

[6] EkhlasFalih Nasser,"Human Face Recognition is Dependent on Computing the Similarity and Difference of the SevenMomentsValues as a Face Features",Eng.&Tech. Journal ,Vol.30, No.11, 2012.

[7] Swarup Kumar and SukadevMeher," Performance Improvement for Face Recognition using PCA and Two-Dimensional PCA", International Conference on Computer Communication and Informatics(ICCCI), Coimbatore,India,2013.

[8].Shailaja A Patil1 and Dr. P. J. Deore," Face Recognition: A Survey", Informatics Engineering, an International Journal (IEIJ) ,Vol.1, No.1, December 2013.

[9].Maysaa Hameed Al-Hamdani,"Face Image Recognition Using 2D PCA Algorithm",Eng. & Tech. Journal, Vol.31, Part (A), No.7, 2013 .

[10].Yin B., Bai X, Qin S, Sun Y., entitled "Enhanced Fisherface for Face Recognition" Journal of Information & Computational Science 2: 3 (2005) 591-595 .

[11]. T. Ojala, M. Pietikainen, and T. Maenpa." Multiresolution gray-scale and rotation invariant texture classification with local binary patterns". IEEE Trans. on PatternAnalysis and Machine Intelligence, 24(7):971–987,2002.

[12] Ahmed F, Hossain E, Bari A S M H, et al. "Compound local binary pattern for robust facial expression recognition". Proceedings of the 12th IEEE International Symposium on Computational Intelligence and Informatics (CINTI'11), Nov 21-22, 2011, Budapest, Hungary. Piscataway, NJ, USA: IEEE, 2011: 391-395.

[13]. W. Zhao, R. Chellappa, P. Phillips and A. Rosenfeld, "Face Recognition :A Literature Survey," ACM Computing Surveys, vol. 35, no. 4, pp. 399-458, December 2003.