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Study of Dimensionality Reduction Analysis for Expression Recognition using Principal Component Analysis

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Abstract: ***Feature extraction is an important feature of visual defects detection, for that it can transform high dimension space of image data into low dimension space of feature data. But for the pattern classifier, high dimension input will lead the increasing of identification complexity. Therefore, it is necessary to select one group of features that can most express the defect essential characteristics. Principal component analysis is the Eigenface method for the recognition of facial expressions and makes use of the thought of statistical variance, which can remove the correlation between the statistical variables and keep all or most of the information. This paper studies the dimensionality reduction analysis for expression recognition based on Principal Component Analysis.***

Keywords: Feature Extraction; Expression Recognition; PCA; Eigenfaces.

I. INTRODUCTION

In the present days, face detection continual in requisition in image processing system because of its requirements such as authentication system, access control, and surveillance control systems. Faces can be characterized on the basis of two stages like 1) appearance and 2) Features. Face detection process is categorised into two steps:

A. Face Detection

The detection of the face is whether an image depicts a face that is the general structure of face or not. General structure includes forehead, eyes, nose, lips, eyebrows etc.

B. Face Recognition

Detection of a face is easier than face recognition, face detection is used to detect a face from an image but face recognition is used to find out whose face is this.in order to recognize a face number, there are number of techniques such as PCA (Principal Component Analysis), LBP (Local Binary Patterns), ICA (Independent Component Analysis) LDA (Linear Discriminant Analysis), and so on. These approaches are used for face recognition. Some kind of variations happened that causes problems in face detection and the variations are illumination change, pose variation, RST variation, Cluttering, Occlusion. Face recognition system can improve in many ways. It is used to check criminal records, pattern recognition, increase of security using cameras etc.

Extraction of feature is a significant link of visual defects detection, for it is a significant process to transform the high dimensional space of image data into low dimensional space of feature [1]. Except for the pattern classifier, the expanding amount of input data dimension will lead the increasing of identification complexity. For that reason, it is compulsory to chosen one group of features from all the extraction features that can most express the defect essential characteristics. This process is called as feature selection.

Really feature selection [2-4] is an optimization methodology for the existing feature sets combination, that is, selects a n-dimension feature vector from the original N-dimension feature vector (n<N) to formulate a new feature set, makes this feature set to express the essential criterion of faults correctly, in a lower dimensional feature space, and at the same time to accomplish the purpose of data dimension reduction. Create a depiction with mathematical language, feature selection is a process of making a map from a higher-dimension feature space to a lower-dimension feature space, stand for, the mapping from R^n to R^m, normally n>m, and require the space R^m keep most information of the R^n. Principal Component Analysis (PCA) [5,6] is an efficient approach for statistical data analysis. It creates use of the thought of statistical variance, and can take off the correlation between the statistical variables and keep all or most of the information. From mathematical analysis understanding, PCA really is to discover a best approximation vector for n-dimension space in m-dimension space.

There are various types of method are used for face and non-face with wavelet feature like Adaboost method [7, 9] and also Eigen Face which is also called as PCA method. But In Eigen face method face and non-face image is generated by the Principal Component Analysis (PCA) [7, 8].It is used to contract the given information vector. Face detection algorithm gives location. Principal Component Analysis (PCA) is used to generate the feature vector of face and non-face image in Eigen Face method. Also, PCA is used to compress the given information vector. Kernel function is created to describe face and non-face images in Support Vector Machines (SVM). Face and non-face images are also divided by artificial neuron structure in Neural Networks.

II. Related Work

Shiji S. k et al. (2013)**,** [10] have suggested a new approach for face detection is concluded by Principal Component Analysis (PCA). Face images are designed onto an experience space that converts best variation among known face images. The face area space is characterized by Eigen face which can be eigenvectors of the group of faces that might not match general facial features like for instance eyes, nose, and eyebrows. The Eigen face method uses the PCA for detection of the images. Computers that detect and recognize faces might be placed on a wide selection of practical applications enclose security systems, criminal identification, identity verification etc. Zahid Riaz et al. (2005), [11] have suggested a new approach of classifying the humans on the basis of their contracted face images. Classification technique utilizes PCA in certain different way. Only first principal component is used as feature vector out of 92 components (since image size is 112x92), causing an improved result of 87.39%. Janarthany Nagendrarajah et al. (2010), [12] have suggested this model suggested a method to contend recognition where in fact the facial expression in working out image and in the testing image deviate and absolute a single selection image per class can be gained to the machine. This technique has been used on new pictures to have the capability to eliminate a few Eigen-images known as Eigen encounters and loads with this particular illustration are applicable for recognition. For the classification job, range full Euclidean Range has been applied to acquire the exact distance with the fat vectors attached with the education images. When calculable with ten topics and six standard words the full acceptance cost was 89%, for skilled encounters. Patrik Kamencay et al. (2012**),** [13] has also suggested a new approach centered on pre-processing face images using segmentation algorithm and SIFT (Scale Invariant Feature Transform) descriptor the paper represents a suggested methodology for face recognition. Karande Kailash J. et al. (2012), [14] the condition of experience acceptance applying Laplacian pyramids with various orientations and separate parts is resolved in that paper. The edginess like data is received by with four various orientations (00, 450, 900, and 1350) then pre-processing is performed by utilizing Concept Part evaluation (PCA) before acquiring the Separate Components. The disjoin parts received by ICA methods are used as function vectors for classification. The Euclidean range (L2) classifier is useful for screening of photographs. D.A. Meedeniya et al. (2007), [15] have also suggested a new method for face recognition. This process depends on an opposite of utilizes Principal Component Analysis (PCA) technique. The algorithm extracts the Eigen values and Eigen vectors from the images. It functions the financial measurement single price decomposition to acquire a unitary matrix, which will be used for recognition. The pictures are acknowledged bottom on the minimum distance. This algorithm can achieve 93.7% and higher performance.

Lingling Peng et al. (2012), [16] have suggested a new Theory Vectors Subspace (TVS) for experience recognition. Firstly, use PCA to get each aspect vector; accordingly we achieve a subspace which results theory vectors of every aspect. In order to evaluate the performance make a comparison of PCA, KPCA on the ORL and AR databases.

Ban Jozef et al. (2013) , [17] have given a comparative study of several conventional face detection methods (PCA a.k.a. Eigen faces, RBF) and novel kernel methods (KPCA, GDA and SVM) which are capable to work efficiently below the conditions. The proposed paper centered on occlusions of eyes and eyebrows as they are probably the most significant options that come with a face. Face recognition considered by machine learning methods with accuracy considered by human perception only are analogized. Zhiyong Zeng et al. (2013), [18] have also suggested a new method for face description and recognition using shearlets transform and principle component analysis. Lastly, face feature is educed by Principle Component Analysis (PCA).

III. Dimensionally Reduction

Principal Component Analysis uses an orthonormal transformation in order to transform a group of samples from correlated variables into a group of linearly uncorrelated variables. For the application of facial detection system, PCA has extensively been used for dimensionality reduction to be used for effective classification of algorithms. The principal components are the eigenvalues of the symmetric covariance matrix. The analysis presented in the following sections is based on the ORL image database used for classification.

IV. Proposed Method

The target of this proposed method is to detect the face expression captured from the input image taken from the database of Indian face Databases. For the face acquisition step, it used skin color based face detection method. In between them it uses the median filter to remove unwanted noise. For the face feature extraction and expression recognition step, it used the eigenface method of principal component analysis, which uses a set of single static image with different expression labels as the training database, projection of dataset into the expression to subspaces, and resulted out the similar face expression in the training database, thus gave out the label of that face as the recognition result of captured face. Figure 2 below expresses the major stages of the proposed method followed by the detailed implementation explanation.

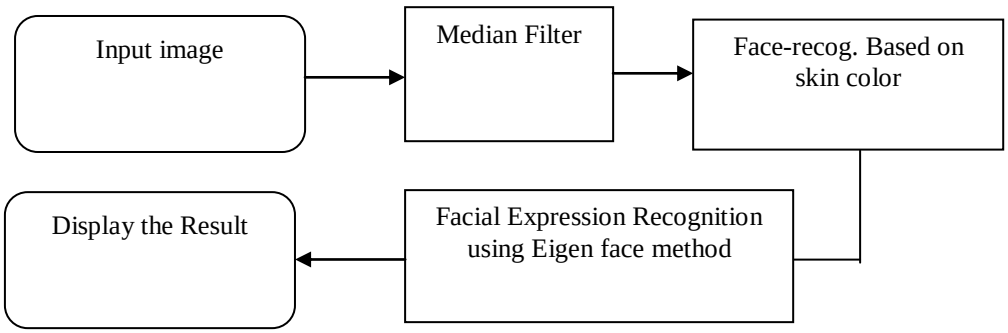

Fig. 1. Major steps of Proposed System

A. Input Image

The objective of this step is to take a static image of the user face with certain expression from the database. The input image was served as the test picture to be recognized later. The input picture was suggested to be saved to the test image file for further use. Figure 3 below showed the interface of this step.

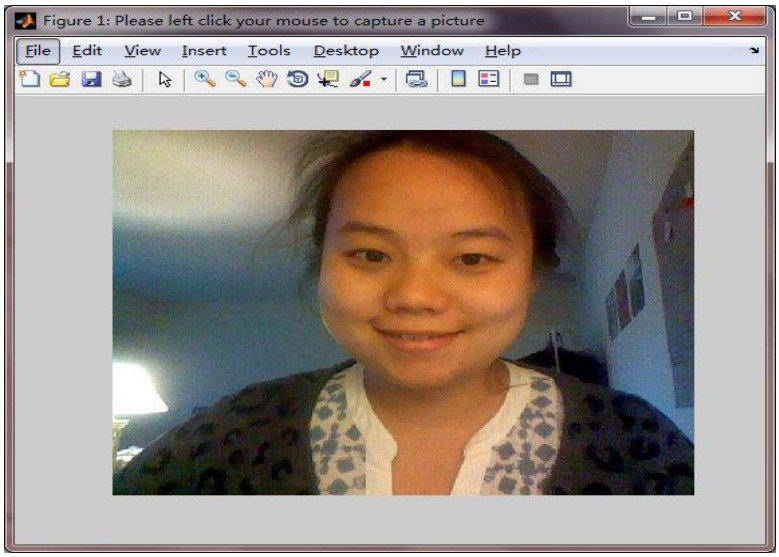

Fig. 2. Input Image

B. Face Detection in a given Image

Considering that the input image from the database, there would mainly be one face sitting in the center of the picture. So a relatively simple face detection method would work here. The skin color based face detection is based on the study that in the YCbCr color space, the skin color of human is concentrated distribution [19]. So we read in the captured picture, turned it to YCbCr color and detected the Cr color in the following range: 10<Cr & Cr<255. Thus we get the skin area. As there has already been toolbox for this function, Tolga Birdal's code was cited and used in this step [20].Figure 4 below showed the interface of this step.

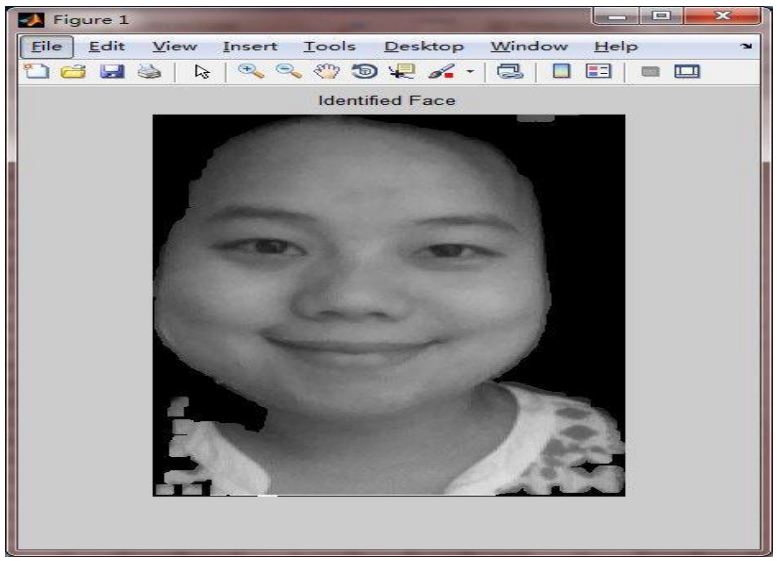

Fig. 3: The step of face recognition

C. Compute the Eigen subspaces

The training images and the input images were all pre-processed by the load image function (loadImage.m): resize and generate the matrix as the input for the PCA (Principal Component Analysis) function (princomp from the MAT Lab toolbox). Then the training images were loaded to generate a low dimensional face space and also the projected versions of all these training images. The input image was also projected onto the face space, which means that the input image was represented by the selected principal components [21] [22].

Fig. 4. Example of Eigenface

D. Median Filter

In signal processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median **filter** is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

E. Recognition

The Euclidian distance of the projected test image from each projected training image was calculated. The minimum Euclidian distance represented that the right training image was the most similar one to the captured image, which means they were considered to be sharing the same label of the face expression on that training image [21] [22].

V. Techniques for Expression Recognition

For the identity of the person, face is the primary focus. Facial expression detection is nothing but the detection of the face and then recognizes the expression of the detected face. There are many expressions like happy, sad, angry, neutral, disgust, surprise etc. Many algorithms give the best result to find out the facial expressions for example,

1. PCA Algorithm,
2. GABOR Algorithm
3. SVD Algorithm, and

Feature extraction means extracting certain feature points on the face like

1. Eyebrows
2. Nose
3. Lips
4. Eye

A. Theory of PCA

PCA is a main method used for recognition of statistical design to put in order to reduce dimensionality and also used for feature extraction. It is used to conserve the significant knowledge of the pattern and is used to eliminate excess information. Given a database contains number of images; the task of a face detection system is to show that the picture on which testing is

performed belongs to a person in the repository. A face contains fixed set of features and these characteristic features are called principal components or Eigen faces. These features can be extracted from the original image with the help of Principal Component Analysis (PCA). Appearance of a face image of size D X D can be considering as D2 1-dimensional vector in order to reduce dimensionality.

Principal Component Analysis is a technique that extracts the absolute most applicable information within a face and then offer to construct a computational product that best describes it. Given a database contains number of images; the task of a face recognition system is to perform the check picture goes to an individual in the depository. A face contains certain set of features and these characteristic features are called principal components. These features can be extracted from the original image with the help of principal component analysis.[23]

B. Flowchart for PCA method

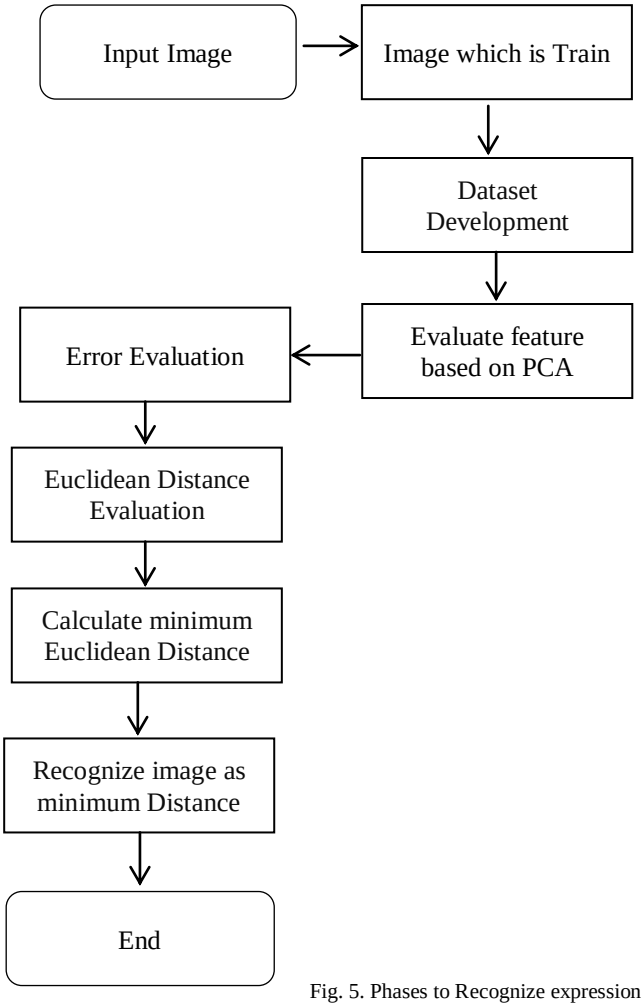

Fig. 5. Phases to Recognize expression and face

PCA Algorithm: This method of expression recognition involves the following initialization operations: [24]

1. First it gathers the set having initial face images which we called as training set that creates the training dataset.
2. Then the calculation of the eigenfaces from that training set images and keep the record of D images which have the highest eigenvalues and other images can be unloaded.
3. These D images are called as face space. When new eigenfaces are obtained then this face space can be displaced with that values.
4. After that compare the images using an eigen and value which matches closely.

Facial Expression	Recognition Rate using PCA
HAPPY	98.00
DISGUST	75.00
ANGER	80.00
SAD	85.00
NEUTRAL	60.00

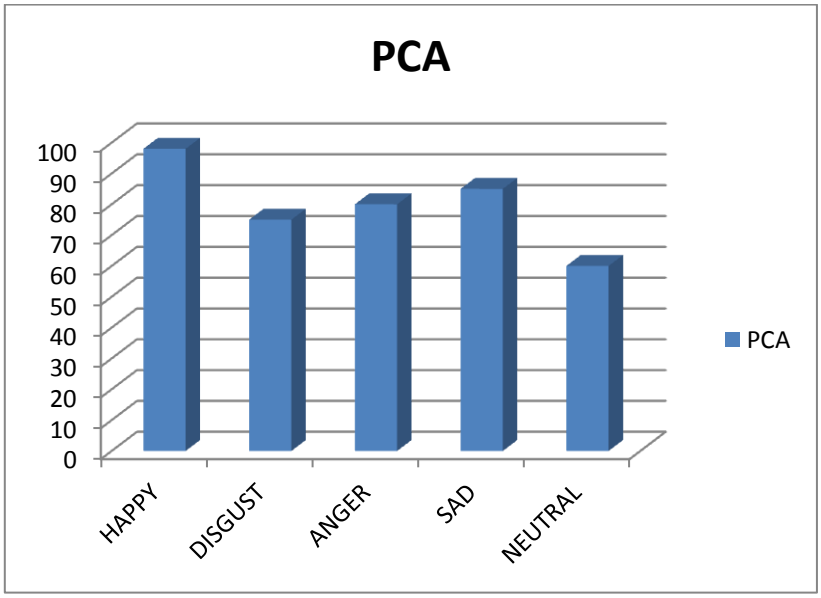

Fig. 6. PCA Efficacy for Various Expressions

VI. RESULTS

Fig. 7. Before the Detection of Face

Fig.8. After the Detection of Face

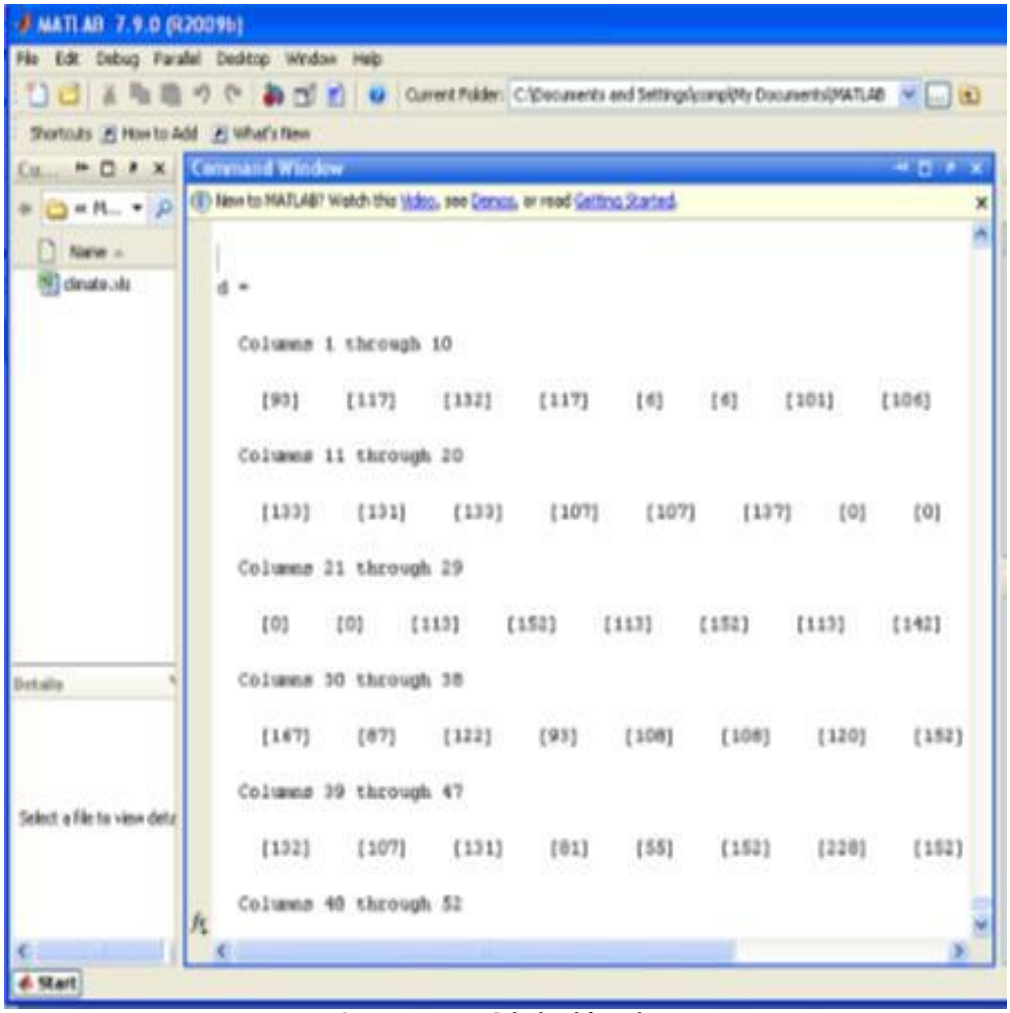

Fig. 9. Features Point Calculated from the Image

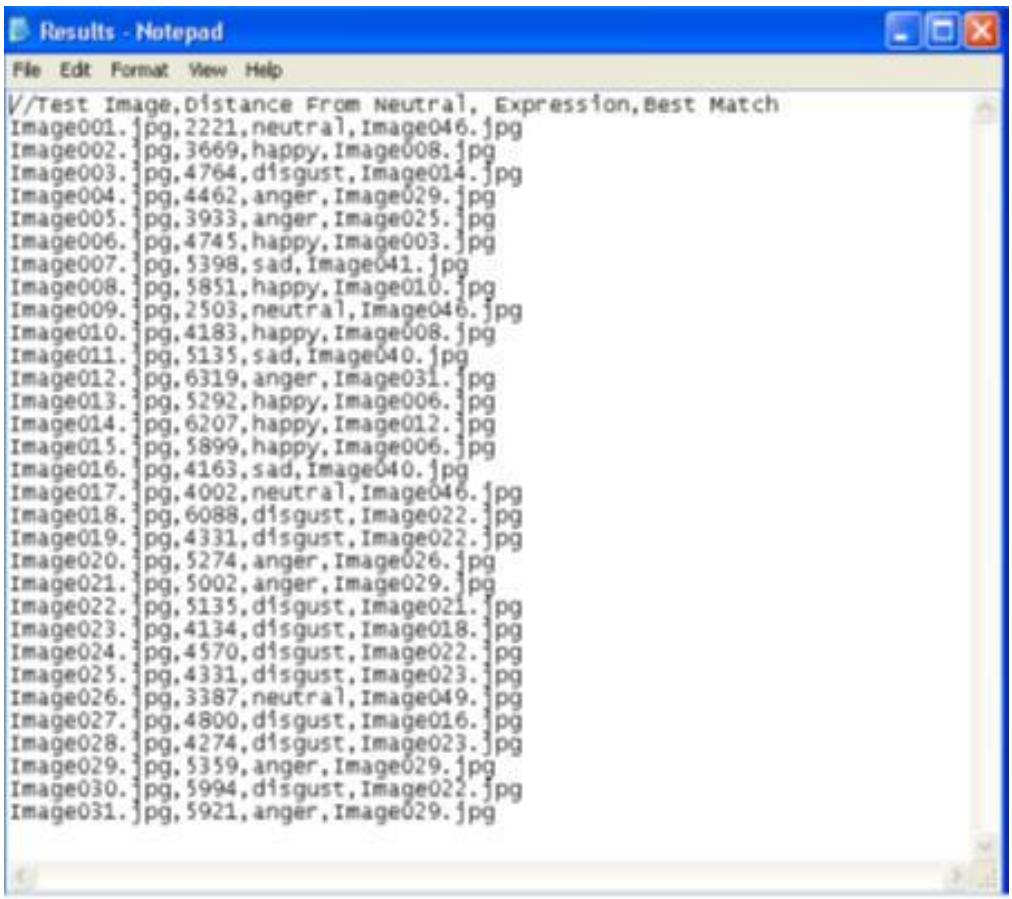

Fig10. Recognized Expressions of Every Image

VII. CONCLUSION

This proposed system is implemented for the recognition of facial expression automatically. In this first we extract the face region. And then in that we extracted the features like lips, nose, eyes, eye brow etc using PCA algorithm. Then we calculate the eigen vectors and compare with the real database as well as standard database. The experimental analysis shows the accuracy of the system on different expressions using PCA algorithm. The result shows that the recognition rate for the expression happy is highest which shows in graph of PCA.

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