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Facial Expression Recognition with PCA And LDA

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***Abstract* -- Facial expression provides an important behavioural measure for studies of emotion, cognitive processes, and social interaction. Facial expression recognition has recently become a promising research area. Its applications include human-computer interfaces, human emotion analysis, and medical care and cure. In this paper, we are evaluating the performance of PCA and LDA to recognize seven different facial expressions of two individuals such as happy, neutral, angry, disgust, sad, fear and surprise, in the JAFFE database. Our aim is to represent best techniques which work best for facial recognition. The present study proves the feasibility of facial expression recognition for practical applications like surveillance and human computer interaction.**

***Index Terms* -- Facial expression; feature representation; Face Recognition; Principal Component Analysis; Linear Discriminant Analysis; Euclidian Distance.**

I. INTRODUCTION

A human face carries a lot of important information while interacting to one another. In social interaction, the most common communicative hint is given by one's facial expression. Mainly in psychology, the expressions of facial features have been largely considered. As per the study of Mehrabian [1], amongst the human communication, facial expressions comprises 55% of the message transmitted in comparison to the 7% of the communication information conveyed by linguistic language and 38% by paralanguage. This shows that the facial expression forms the major mode of interaction between the man and machine. Since for communicating the non-verbal messages the face forms the basis, the ability to read the facial emotions becomes an important part of emotional intelligence [2].

In recent years, a lot of work has been done on the affective recognition of expressions which holds the major key in the human-machine interaction. The research on the facial emotions across different cultures points out that the recognition of expressions is universal and established as constant across cultures. The first suggestion of expression of emotions as universal was given by Charles Darwin in his contriving work build from his theory of evolution. Then the psychologist Ekman and Friesen showed in their cross culture studies that the seven emotions "happiness, sadness, anger, neutral, surprise, disgust and fear" are interpreted in the same way and are universal across cultures, which are known as the seven basic expressions.

II. DIFFERENT TECHNIQUES OF FACIAL RECOGNITION

A. Discrete Wavelet Transform (DWT):

Discrete Wavelet Transform (DWT) is a suitable tool for extracting image features because it allows the analysis of images on various levels of resolution. Typically, low-pass and high-pass filters are used for decomposing the original image. The low-pass filter results in an approximation image and the high-pass filter generates a detail image. The approximation image can be further split into a deeper level of approximation and detail according to different applications. Suppose that the size of an input image is N × M. At the first filtering in the horizontal direction of down-sampling, the size of images will be reduced to N×(M/2). After that, further filtering and down-sampling in the vertical direction, four sub images are obtained, each being of size (N/2)×(M/2). Fig. shows the sub-band decomposition of an N ×M image, where H and L respectively denote high-pass and low-pass filters, and ↓2 denotes down-sampling by a factor of 2. where l[n] and h[n] are coefficients of low-pass and high-pass filters, respectively. Accordingly, we can obtain four images denoted as LL, HL, LH and HH. The LL image is generated by two continuous low-pass filters; HL is filtered by a high-pass filter first and a low-pass filter later; LH is created using a low-pass filters.

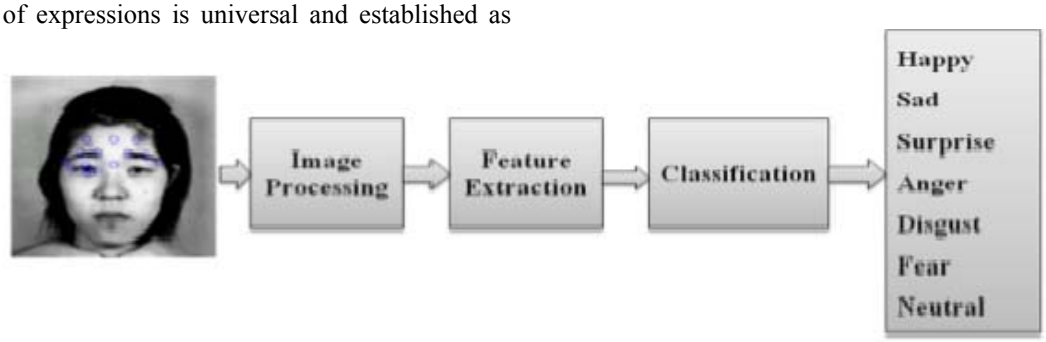

Fig: Facial Expression Recognition Overview.

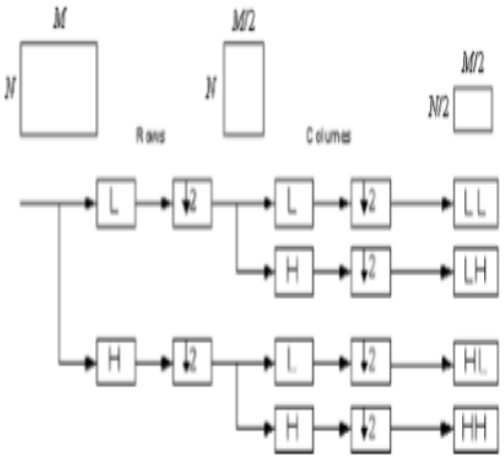

Fig: Sub-Band Decomposition of an N x M image.

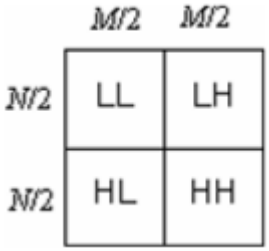

Fig: First-Level Decomposition.

and followed by a high-pass filter; HH is generated by two successive high-pass filters. Figure 3 illustrates the first-level decomposition. Every sub image can be decomposed further into smaller images by repeating the above procedure. The main feature of DWT is the multiscale representation of a function. By using the wavelets, a given image can be analyzed at various levels of resolution. Since the LL part contains most important information and discards the effect of noises and irrelevant parts, we adopt the LL part for further analysis in this paper. We extract features from the LL part of the second-level decomposition. The reasons are the LL part keeps the necessary information and the dimensionality of the image is reduced sufficiently for computation at the next stage.

B. PCA and LDA

Principal Component Analysis (PCA) is widely used for feature representation. In this paper, we use PCA as a comparison with the Linear Discriminant Analysis [3]. The central idea behind PCA is to find an orthonormal set of axes pointing in the direction of maximum covariance in the data. In terms of facial images, the idea is to find the orthonormal basis vectors or the eigenvectors of the covariance matrix of a set of images, with each image being treated as a single point in a high-dimensional space. Since each image contributes to each of the eigenvectors which resemble ghost- like faces when displayed, it is referred to as eigenface, and the new coordinates system is referred to as the face space. Individual images can be projected onto the face space and represented exactly as weighted combinations of the eigenface components. The resulting vector of weights that describes each face can be used in data compression and face classification. Data compression relies on the fact that the eigenfaces are ordered, with each one accounting for a different amount of variation among the faces. Compression is achieved by reconstructing images using only those few eigenfaces that account for the most variability. It results in dramatic reduction of dimensionality. Classification is performed by projecting a new image onto the face space and comparing the resulting weight vector with the weight vectors of a given class. In LDA, we use the image vector to compute the between-class and within-class scatter matrices. The criterion is to project the images onto a subspace that maximizes the between- class scatter and minimizes the within-class scatter of the projected data. Since the total scatter of the projected samples can be represented by the trace of the covariance matrix of the projected feature vectors [4].

III. CLASSIFIER

A. E-D (Euclidean Distance)

The Euclidean distance has been used to calculating the distance between the image which are to be tested and the already available images used as the training images. Then the minimum distance is observed from the set of values. In testing, the Euclidean distance (ED) has been computed between the new (testing) image Eigenvector and the Eigen subspace for each expression, and minimum Euclidean distance based classification is done to recognize the expression of the input image [7]. The formula for the Euclidean distance is given by

$$ED = \sqrt{\sum(x_2 - x_1)^2}$$

IV. THE JAFFE DATABASE

The image database we use in our experiment is the JAFFE (Japanese female facial expressions) database. This dataset is used as the benchmark database for researchers. The database contains seven Japanese females images. There are seven different facial expressions, such as neutral, happy, angry, disgust, fear, sad and surprise. Each female has two examples for each expression. Totally, there are 213 grayscale facial expression images in this database [6]. Each image is of size 256×256. The two expressors comprising seven different facial expressions from the JAFFE database.

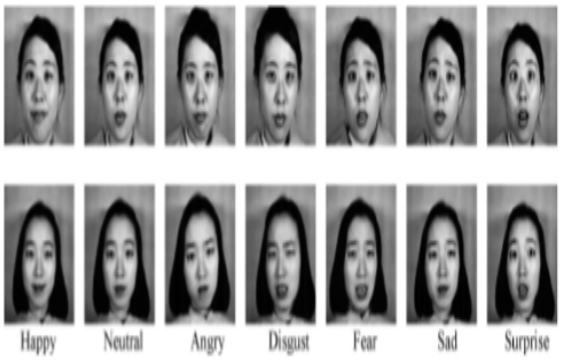

Fig: Sample of two expressors containing seven different facial expressions.

V. EXPERIMENT RESULT

We applied PCA and LDA technique to perform comparison on 14 images with Euclidean Distance.

Methods	Total Images	Recognized Images	Recognised Rate
PCA	14	9	70%
LDA	14	4	30%

TABLE: The Comparisons of PCA and LDA.

VI. IMPLEMENTATION

All codes are written in MATLAB. It uses Graphical User Interface (GUI). The JAFFE database has been used. In this paper we worked on 14 images of 7 facial expressions (Happy, Sad, Angry, neutral, fear,surprise and Disgust).we have calculated the Euclidean distances between images of same expressions of two persons.

VII. RESULT AND CONCLUSION

In this paper, we work on PCA and LDA with Jaffe database. PCA recognition rate is 70% and in case of LDA the recognition rate is 30%. In LDA rejection rate is higher. PCA is widely accepted but its performance is degraded when it's implemented on facial expressions. At last, we conclude that we can improve the performance by using the hybrid approach like neural network and fuzzy logic.

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