COMPARITIVE STUDY OF DIMENSION REDUCTION TECHNIQUES FOR MOOD DETECTION

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Abstract: *The expression recognition system is closely related to face recognition where a lot of research has been done and a vast array of algorithms has been introduced. The mood detection system can also be considered as a special case of a pattern recognition problem and many techniques are available. In the designing of a Mood Detection System, we can take advantage of these resources and use existing algorithms as buildin g blocks of our system. In this research work comparative study of mood detection techniques namely Principal Component analysis (PCA), PCA with Fisher face is done. The major part of this paper will explore and compare that the combination of PCA and Fisher face is more optimized than former technique. The experiments have been performed on real time database to figure out the performance of desired algorithm in terms of recognition rate and computational time. There are five different moods which are to be recognized are: Happy, Disgust, Angry, Sad and Surprise.*

Keywords: *Mood detection system, Recognition rate, Fisher face, Principal component analysis (PCA). etc*

I. Introduction

The Facial Mood Recognition Module recognizes one of the six basic facial moods(e.g. anger, happiness, neutral state) on facial images that have already been detected/tracked in video frames or camera. The Facial Expression Recognition Module provides functions to identify the facial expressive state of each person appearing in video at every video frame. The set of facial expressions that can be recognized includes anger, disgust, fear, happiness, sadness, surprise and the neutral stateFacial moods are one of the most powerful, natural, and immediate means for human beings to communicate their emotions and intentions. A facial mood carries crucial information about the mental, emotional and even physical states of the conversation. . It is a desirable feature of the next generation human-computer interfaces. Computers that can recognize facial expressions and respond to the emotions of humans accordingly enable better human-machine communication development of information technology Recognition of facial expression in the input image needs two functions: locating a face in the image and recognizing its expression. We believe recognition of human facial expression by computer is a key to develop such technology. In recent years, much research has been done on machine recognition of human Facial expressions [21][22]. One of the key **re**maining problems in face recognition is to handle the variability in appearance due to changes in pose, expression, and lighting conditions. There has been some recent work in this direction. The increasing progress of communication technology and computer science has led us to expect the importance of facial expression in future human machine interface and advanced communication, such as multimedia and low-bandwidth transmission of facial data In human interaction, the articulation and perception of facial expressions form a communication channel, that is additional to voice and that carries crucial information about the mental, emotional and even physical states of the conversation [6][7]. Face localization, feature extraction, and modeling are the major issues in automatic facial expression recognition [12].

II. LITERATURE SURVEY

Marian et. al. compared several techniques, which included optical flow, principal component analysis, independent component analysis, local feature analysis and Gabor wavelet representation, to recognize eight single action units and four action unit combinations using image sequences that were manually aligned and free of head motions.[3] G. R. S. Murthy et. al. made Computer Systems to recognize and infer facial expressions from the user image. They proposed a method of facial expression recognition, based on Eigenspaces. They also identified the user's facial expressions from the input images, using a method that was modified from eigenface recognition. Thay had evaluated method in terms of recognition accuracy using two well known Facial Expressions databases, Cohn- Kanade facial expression database and Japanese Female Facial Expression database. The experimental results shown the effectiveness of scheme [16]. Mandeep Kaur et. al. paper presented a new idea for detecting an unknown human face in input imagery and recognizing his/her facial expression. The objective of this project is to implement highly intelligent machines or robots that are mind implemented[19]. Fasel et. al. [11] fulfills the recognition of facial action units, i.e., the subtle change of facial expressions, and emotion-specified expressions. The optimum facial feature extraction algorithm, Canny Edge Detector, is applied to localize face images, and a hierarchical clustering-based scheme reinforces the search region of extracted highly textured facial clusters. Preetinder Kaur et. al. proved an efficient method in pattern recognition and image analysis. PCA has been extensively employed for face recognition algorithms, such as Eigen face and fisher face Feature Extraction has been the subject of much attention in recent years. It has been used as a powerful tool for face recognition. They studied Principal component analysis (PCA) techniques of feature extraction [18].

III. FACIAL EXPRESSION DATABASE

The most of database used for facial expression system is Real time database. This database contains 50 images of 7 facial expressions including neutral posed by an individual. Each image represents different expression per emotion. Face database contains 24 colored face images of individual. There are 8 images per emotion, and these 8 images are, respectively, under the following different facial expressions or configuration. In this implementation, all images are resized to a uniform dimension of 256 x 256. Following Figure shows the database images considered for face Expression recognition could be used.

Fig.3 (a): *Samples of Database used for Mood Detection System*

I. Dimension Reduction Techniques

In statistics, dimension reduction is the process of reducing the number of random variables under consideration, and can be divided into feature selection and feature extraction**. There are following types of dimension reduction techniques explained in detail below.**

A. Principal Component Analysis

In this approach, the face images are decomposed into a small set of characteristic feature images called “Eigen faces” (which contain the

common features in a face) which are extracted from the original training set of images by means of principal component analysis. An important feature of PCA is that any original image can be reconstructed from the training set by a linear combination of the Eigen faces. Each Eigen face represents only certain features of the face. However, the losses due to omitting some of the Eigen faces can be minimized by choosing only the most important features (Eigen faces).

The Eigen face approach involves the following initialization operations:

1. An initial set of images (training set) is acquired.
2. The Eigen faces from the training set are calculated and only M images that correspond to the highest Eigen values define the face space.
3. By projecting the face images onto the face space, the corresponding distribution in M-dimensional weight space for each individual image is found.

With these weights, any image in the database can be reconstructed using the weighted sum of the Eigen faces.

In order to recognize face images, the following steps are to be followed

1. A set of weights based on the input image and the M Eigen faces are calculated by projecting the input image onto each of the Eigen faces.
2. Nearest neighbor classification is used in order to find out the unknown image in the training set.

B. Fisher Face Technique

Fisher's linear discriminant is a methods used in statistics, pattern recognition and machine learning to find a linear combination of features which characterize or separate two or more classes of objects or events. The resulting combination may be used as a linear classifier, or, more commonly, for dimensionality reduction before later classification.

LDA is closely related to ANOVA (analysis of variance) and regression analysis, which also attempt to express one dependent variable as a linear

combination of other features or measurements.[1][2] In the other two methods however, the dependent variable is a numerical quantity, while for LDA it is a categorical variable (*i.e.* the class label). Logistic regression and probit regression are more similar to LDA, as they also explain a categorical variable. These other methods are preferable in applications where it is not reasonable to assume that the independent variables are normally distributed, which is a fundamental assumption of the LDA method.

LDA is also closely related to principal component analysis (PCA) and factor analysis in that both look for linear combinations of variables which best explain the data. LDA explicitly attempts to model the difference between the classes of data. PCA on the other hand does not take into account any difference in class, and factor analysis builds the feature combinations based on differences rather than similarities. Discriminant analysis is also different from factor analysis in that it is not an interdependence technique: a distinction between independent variables and dependent variables (also called criterion variables) must be made.

II. IMPLEMENTATION

The implementation of the algorithm is done in Matlab 7.1.1 environment and Image Processing toolbox in Matlab is used. The database used for Facial Expression System is Real time database. For the implementation of mood detection a real time database data is used. Face database contains 50 colored face images of individual. There are 8 images per emotion, and these 8 images represents different expressions of face . In this implementation, all images are resized to a uniform dimension of 256 x 256. The complete flow chart of methodology is shown in fig. 5(a).

A. Implementation on real time database using PCA

We have conducted experiment on 50 images of different facial expressions from real time . There are 26 test images in testing dataset

which are compared with 50 train images in training dataset to recognize facial expressions. The images are of uniform dimensions of 256x256 sizes.

B. Implementation on Real time database using Fisher Face

We have experimented on The Real Time Database. Database contains (50 images of which 7 facial expressions including neutral images). The Database contains different images of an individual which represents different moods according to different situations. For the implementation the Database contains 50 coloured face images of individual. There are 8 images per emotion, and these 7 images are respectively, under the following different facial expressions or configuration. In this implementation, all images are resized to a uniform dimension of 256 x 256. Vigorous experimentation is done by selecting proper number of epochs, number of runs, step size on randomize data set to generalize the problem. Input image forms the first state for the face recognition module. To this module a face image is passed as an input for the system. The input image samples are considered of non-uniform illumination effects, variable facial expressions, and face image with glasses. In second phase of operation the face image passed is transformed to operational compatible format, where the face Image is resized to uniform dimension; the data type of the image sample is transformed to double precision and passed for Feature extraction. In Feature extraction unit runs both Fisherface and PCA algorithms for the computations of face for extraction. These features are passed to classifier which calculates the minimum Euclidean distance from the neutral image and the image having minimum distance is selected for output. For the implementation of the proposed recognition architecture the database samples are trained for the knowledge creation for classification. During training phase when a new facial image is added to the system the features are calculated and aligned for the dataset formation. Comparing the weights of the test face with the known weights of the database is found by calculating the norm of the differences between the test and known set of weights, such that a minimum difference between any pair would symbolize the closest match.

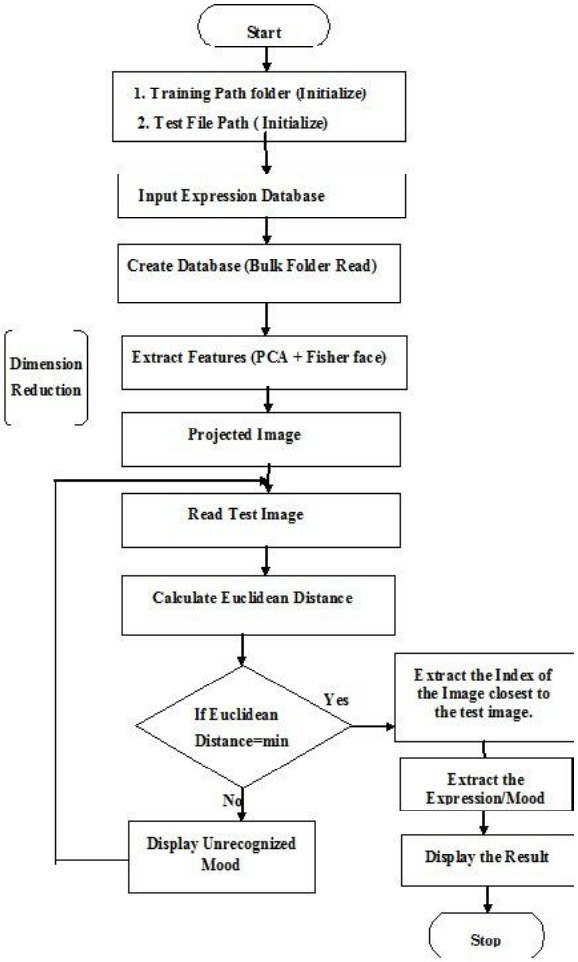

Fig. 5(a): *Flow Chart of our Research Work*

I. Result and Discussion

The optimally design PCA and Fisher face algorithms tested on the training set. The results obtained are brilliant. The recognition rate for all seven principal moods namely Sad, Contempt, Fear, Joy, Disgust, Angry and Astonished along with Neutral is obtained which is more than previous existing techniques. Finally the network is tested on real time dataset with excellent recognition rate.

A	B	C	D
Test Image	distatance From Neu	Expression	Best Possible Match
Image001.jpg	2535	neutral	Image046.jpg
Image002.jpg	4190	happy	Image008.jpg
Image003.jpg	5435	disgust	Image014.jpg
Image004.jpg	5097	anger	Image029.jpg
Image005.jpg	4487	anger	Image025.jpg
Image006.jpg	5416	happy	Image003.jpg
Image007.jpg	6154	sad	Image041.jpg
Image008.jpg	6675	happy	Image010.jpg
Image009.jpg	2852	neutral	Image046.jpg
Image010.jpg	4773	happy	Image008.jpg
Image011.jpg	5864	sad	Image040.jpg
Image012.jpg	7205	anger	Image031.jpg
Image013.jpg	6027	happy	Image006.jpg
Image014.jpg	7075	happy	Image012.jpg
Image015.jpg	6718	happy	Image006.jpg
Image016.jpg	4755	sad	Image040.jpg
Image017.jpg	4569	neutral	Image046.jpg
Image018.jpg	6938	disgust	Image022.jpg
Image019.jpg	4939	disgust	Image022.jpg
Image020.jpg	6012	anger	Image026.jpg
Image021.jpg	5700	disgust	Image021.jpg
Image022.jpg	5852	disgust	Image021.jpg
Image023.jpg	4710	disgust	Image018.jpg
Image024.jpg	5211	disgust	Image022.jpg
Image025.jpg	4940	disgust	Image023.jpg
Image026.jpg	3865	neutral	Image049.jpg
Image027.jpg	5473	disgust	Image016.jpg
Image028.jpg	4883	disgust	Image023.jpg
Image029.jpg	6111	anger	Image029.jpg
Image030.jpg	6836	disgust	Image022.jpg
Image031.jpg	6756	anger	Image029.jpg

Fig.6(a) *Facial Expression Recognition Results Obtained on Real Time Database*

The output file of worksheet is automatically created when we run the algorithm on our machine. This output file represents the three columns like training images from training folder, Euclidean distance from neutral image and test images from test folder. With the help of this excel worksheet(Fig.5.1) we can calculate various results like mood recognition rate and plot the graph for Euclidean distance from neutral image from where we can judge the closet image to the neural image and can also find that the Fisher Face plus PCA can collectively generate better results than in comparison to PCA algorithm. This file of worksheet is created in the last when algorithm was completely run by the machine. The column on the extreme right side of the picture represents the images from test folder and extreme right represents images from test folder.

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A. Comparative Study of Results from PCA and PCA with Fisher Face

Table 1: Comparison of Recognition Rates for Various Facial Moods on Test Images using PCA and PCA with Fisher face

Facial Expression	Recognition Rate using PCA and Fisher face	Recognition Rate using PCA
Happy	98	95
Disgust	90	70
Sad	95	90
Surprise	94	85
Angry	84	60

The above mentioned table represents comparison of two algorithms which we have implemented on real time database. Also with the help of this table we can compare that for which particular emotion there is more recognition rate and for which emotion there is less recognition rate, So that we can finally improve the recognition rate of particular emotions with another methodology in the upcoming future.

The below mentioned figure1 and figure2 plots the line graph which represent distance of different scrambled test images where expressions are taken in order as represented in figure 3 .The algorithms applied in this figure are PCA and PCA with Fisher face respectively. This plot of a graph is helpful in doing analysis of Euclidean distance for different images. As we have seen in the graph that some images are very close to neutral image than other images because these images have been better recognized by our algorithm.

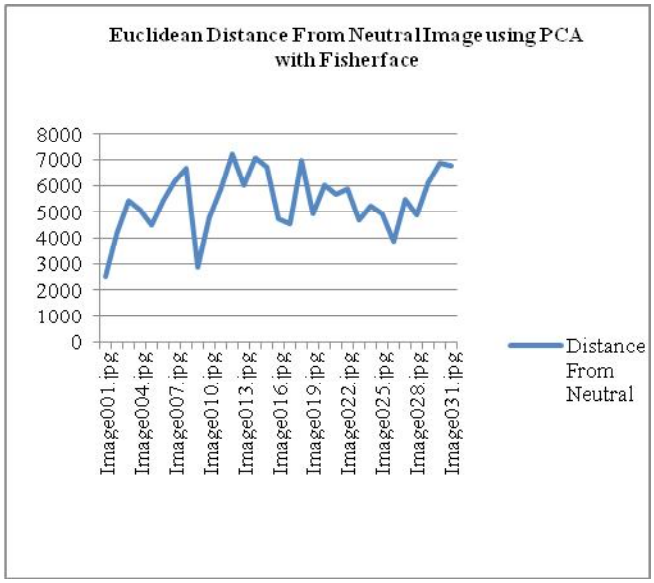

***Fig. 6(b):**. Graph representing Euclidean distance from Neutral image using PCA with Fisher face*

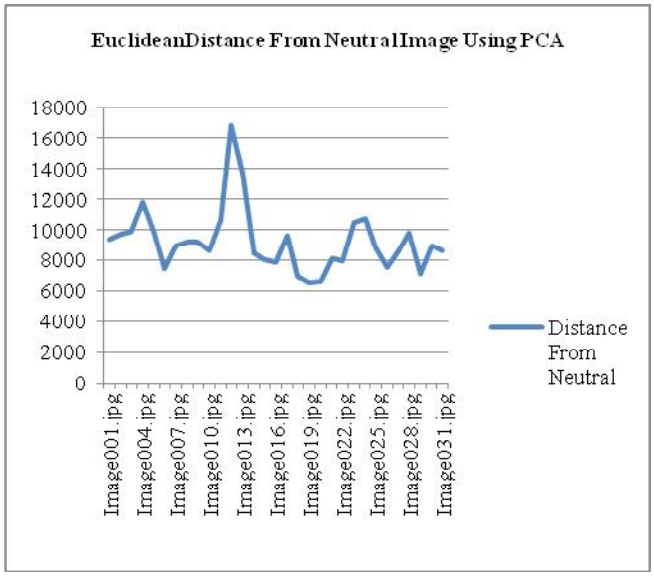

***Fig. 6(c)**: Graph representing Euclidean distance from Neutral image using PCA with Fisher face*

In the below mentioned screen shot from Matlab of bar graph representing computational time in creating database both the algorithms i.e. PCA and PCA plus Fisherface have almost same computational for creating the database. This is also observed during the experiments that this computational time usually vary on the same machine because the situation is when CPU is free i.e. it has less number of applications to run it takes less time to execute the algorithm. This computational time also varies if CPU has high processing speed than others. Another factor which influence the speed of creating database is memory acquired by test folder and memory folder i.e. if the images clicked for mood detection are heavier then the database will take more time to create and vice versa.

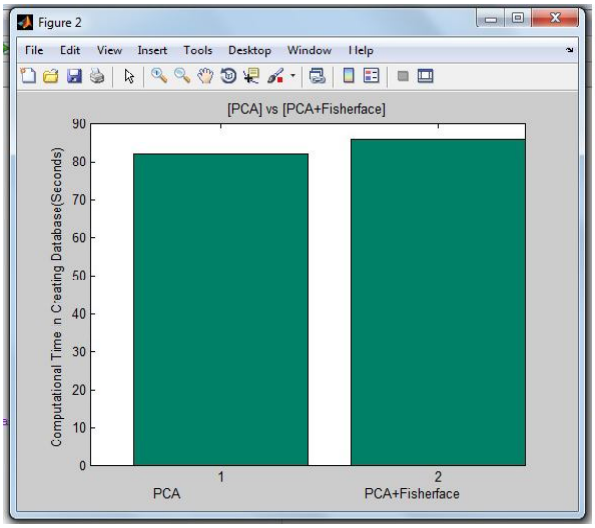

Fig.6(d): *Bar graph representing computational time in creating database*

The below mentioned figure 6(e) represents a bar graph which is helpful in doing analysis of computational time of both the algorithms .According to the graph mentioned above PCA has taken .32 seconds and fisher face plus PCA have taken .401 seconds in execution. Thus it clear and very obvious that PCA plus fisher face program collectively is little bit heavier than alone Fisher face as The second Algorithm has more calculations than first .This is the main drawback of our methodology but his method can be improved in future by optimizing the algorithm.

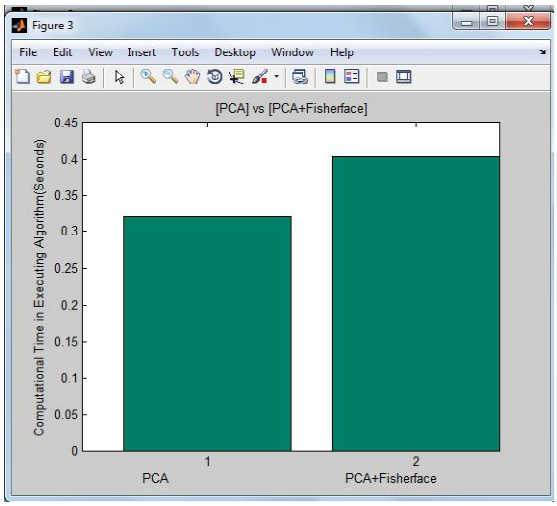

Fig.6(e): *Bar graph representing computational time of Algorithms*

III. Conclusion

In this research paper comparative study of PCA and PCA with fisher face was done.We achieved better results for PCA with fisher face We achieved better result for all principal emotions along with Neutral on training dataset using PCA with fisherface. However, there are still many challenges and problems to solve in such systems, especially in the area of their performance and applicability improvement. In this project we proposed PCA and Fisher face methods for dimension reduction of different types of facial moods. The proposed algorithm is successfully implemented on Real time database. Experiments results show that PCA with fisher face can better effectively recognize different facial moods by indentifying different feature than PCA.

IV. Future Work

In this research work we observed that there are still some setbacks in our project where efficiency needs to be considered. As we know that our methodology has higher mood detection rate but the algorithm still needs to be more optimized so as to reduce the computational time and sometimes it is inevitable to trade of between accuracy and speed. The final step required in future is that gathering a very large number of data is really important in this field of research and it can be always possible to use more. Gathering more emotional words and generating more facial moods can give more accurate results and drive us in different conclusions. Generating more facial moods for each emotion is also very important as there is not only one way to represent an emotion. Find more variations of the emotional facial expressions can be a further step in this research.

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