Facial Expression Recognition Using PCA & Distance Classifier

AlpeshKumar Dauda*
Dept. of Electronics & Telecomm. Engg.
Ph.D Scholar,VSSUT
BURLA, ODISHA, INDIA
alpesh.d123@gmail.com

Nilamani Bhoi
Reader in Dept. of Electronics & Telecomm. Engg.
VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
BURLA, ODISHA, INDIA
nilamanib@gmail.com

Abstract: Face recognition has the most relevance in real life issues of security, criminal investigation, and verification intention. Thus it has a broad range of applications. Three issues in the field of face recognition are: illumination variation , pose variation and more importantly expression variation which is the main focus of this paper. Principal Component Analysis (PCA) is a widely used technology about dimensional reduction. Recently, the PCA has been extensively employed for face recognition algorithms. It is one of the most popular representation methods for a face image. It not only reduces the dimensionality of the image, but also retains some of the variations in the image data. The proposed method has been evaluated using the Feedtum database. Experimental results show that the proposed method has encouraging recognition performance.

Keywords: Face Recognition, PCA, eigen faces, Euclidian distance, Feedtum Database

I. INTRODUCTION

Recent psychological research has shown that facial expressions are the most expressive way in which humans display emotion. The verbal part of the message contributes only 7% of the effect of the message as a whole, and the vocal part 38%, while facial expression contributes 55% of the effect of the speaker's message [4]. Therefore, automated and real-time facial expression recognition would be useful in many applications, e.g., human-computer interfaces, virtual reality, video-conferencing, customer satisfaction studies, *etc.* in order to achieve the desired result. Although humans detect and interpret faces and facial expressions in a scene with little or no effort, accurate facial expression recognition by machine is still a challenge. Several research efforts have been made regarding facial expression recognition. In general, facial expressions are divided by psychologists into six basic categories: anger, disgust, fear, happiness, sadness, and surprise.

Face recognition systems architecture broadly consists of the three following tasks:

- Acquisition (Detection, Tracking of face-like images)
- Feature extraction (Segmentation, alignment & normalization of the face image)
- Recognition

A. *Face Detection Approaches*

Some of the main face detection methods are discussed here.

- Knowledge based methods are developed on the rules derived from the researcher's knowledge of human faces. Problem in this approach is the difficulty in translating human knowledge into well defined rules.
- Featured-based methods: Invariant features of faces are used for detecting texture, skin color. But features from such algorithm can be severely corrupted due to illumination, noise and occlusion.
- Template matching: Input image is compared with predefined face template. But the performance here suffers due to variations in scale, pose and shape.
- Appearance-based method: In template matching methods, the templates are predefined by experts.

Whereas, the templates in appearance based methods are learned from examples in images. Statistical analysis and machine learning techniques can be used to find the relevant characteristics of face and non-face images.

B. *Face Recognition Approaches*

Face recognition can typically be used for verification or identification. In verification an individual is already enrolled in the reference database or gallery i.e. it is a one-to-one matching task whereas in identification, a probe image is matched with a biometric reference in the gallery i.e. it represents a one-to-many problem.

There are two outcomes: the person is not recognized or the person is recognized. Two recognition mistakes may occur: false reject (FR) which indicates a mistake that occur when the system reject a known person, false accept (FA) which indicates a mistake in accepting a claim when it is in fact false.

In the field of face recognition, the dimension of the facial images is very high and require considerable amount of computing time for classification. The classification and subsequent recognition time can be reduced by reducing

dimension of the image data. Principal component analysis (PCA) [Turk and Pentland, 1991] is one of the popular methods used for feature extraction and data representation. It not only reduces the dimensionality of the image, but also retains some of the variations in the image data and provides a compact representation of a face image. The key idea of the PCA method is to transform the face images into a small set of characteristics feature images, called *eigenfaces*, which are the principal components of the initial training set of the face images. PCA yields projection directions that maximize the total scatter across all classes, i.e., across all face images. In recognition process a test image is projected into the lower-dimension face space spanned by the eigenfaces and then classified either by using statistical theory or a classifier.

II. RELATED WORK

In the past years, there are a plenty of work has been done in face recognition and have achieved success in real application. We can divide these algorithms into two main approaches: two dimensional (2D) approaches and three dimensional (3D) approaches. Mainly, the traditional 2D approaches are divided into six algorithms: eigenfaces (PCA), fisherfaces or linear discriminant analysis (LDA), independent component analysis (ICA), support vector machine (SVM), neural network and hidden markov model (HMM) [1]. Jyh-Yeong *et al.* proposes automated facial expression recognition system using neural network classifiers. In this paper [5], they use Rough Contour Estimation Routine (RCER) to get feature of eyebrows, eyes, mouth with the help of Point Contour Detection Method (PCDM) [6] to improve the precision of eye and mouth. They used Action Units (AU) [6] which describes the basic movements of face muscles. Using AU to recognize Facial Expression, they defined 30 facial characteristic points for eye, mouth and eyebrow. For that, they use 80 face images with 128 x 128 pixel resolution and identical environments in terms of illumination, distance and background. After applying the approach, they obtained 92.1% recognition rate. Manal Abdullah *et al.* proposes optimize approach for Face Recognition using PCA (Principal Component Analysis) from digital face image. In this paper [7], they decompose image into small sets of features images or eigen face. First of all they create training dataset to compare result. Once inputted face image is pre-processed and compare with training dataset which are already computed. Highest matching can be achieved by multiple face images but it needs high computation time. They uses FACE94 database and obtained 35% less time over original PCA. They also got 100% recognition rate with this improved method. Murthy *et al.* [8] presented a method for facial expression recognition using eigenfaces in which PCA is used to extract features from input image and test out with training dataset but based on the idea, they divided the training set into six basic classes according to universal expression. They uses CK (Cohn-Kanade) [9] and JAFFE (Japanese Female Facial Expression) [10] database.

III. PROPOSED METHOD

In this article the basic system proposed four stages: Face Detection, Pre-processing, Principle Componenet Anaysis (PCA) and Classification.

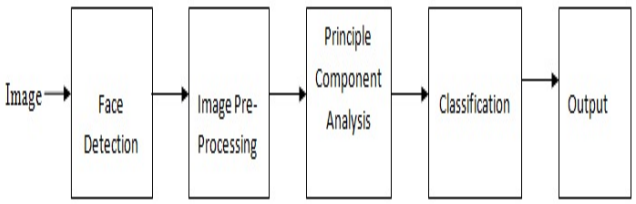

Figure 1. Basic step of Facial Expression Recognition System

The first stage is face detection method. In this method the database of images are almost identical environment of distance, background, etc. the collection of all the images includes different poses of several neutral, anger, disgust, fear, happiness, sadness, and surprise expressions. For creating any type of database some images used for training and some for testing, both of which include number of expressions. The proposed technique is depending on coding and decoding method. First the information is extracted, encoded and then matched with the database of model. Next is the pre- processing module, in this the image gets normalized and it also remove the noise from the image. In eigenface library the database image set divides into two sets- training dataset and testing dataset. The train images are utilized to create a low dimensional face space. This is done by performing Principal Component Analysis (PCA) in the training image set and taking the principal components (i.e. Eigen vectors with greater Eigen values). In this process, projected versions of all the train images are also created. The test images also projected on face space. Then the Euclidian distance of a projected test image from all the projected train images is calculated and the minimum value is chosen in order to find out the train image which is most similar to the test image.

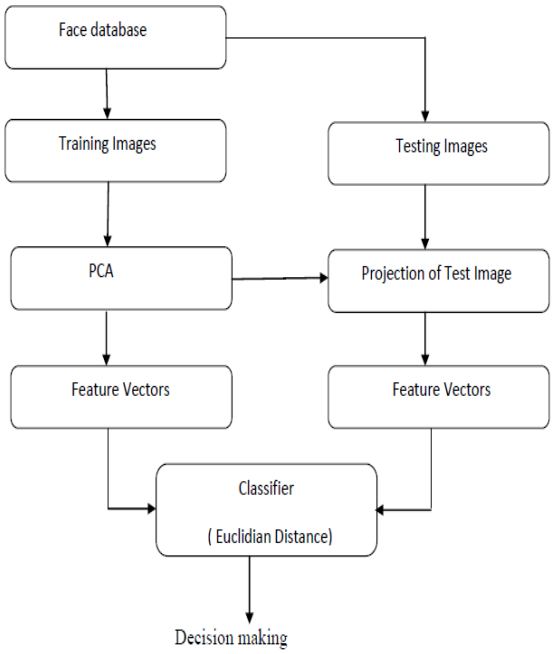

Figure 2. Overview of proposed system

IV. EXPERIMENTAL RESULTS AND PERFORMANCE ANALYSIS

We have tested our results with the Feedtum facial expression database .This database [3] was collected to assist researchers to investigate the effects of different facial expressions. It contains 399 video sequences from 18 subjects. Each subject performed all six basic plus neutral emotions three times, and each sequence starts and finishes with a neutral state. The database attempts to capture real emotions by probing the observed people's natural reaction to video clips or still images, which may result in head movements, instead of asking them to pose for different emotions in one direction.

A database of 50 images of different expression (happy. disgust, anger, sad and neutral) is taken for training purpose. Another image set is used for testing purpose. These images are taken in quite an arbitrary manner. It also includes some faces that are not contained in training set like "fears" and "surprise". For performing the test we have used 35 images (each expression having 5 images) other than those used for training . The results are presented in a tabular form in terms of percentage of success rate and failure rate. It is shown in table I.

Figure 3. Sample images from Feedtum Database

Table I Experiment Result

Facial Expression	*Success rate*	*Failure Rate*
Happy	100	0
Disgust	100	0
Anger	100	0
Sad	80	20
Neutral	100	0

Table II. Confusion Matrix of seven Basic Facial Expression

	Anger	Disgust	Fear	Happy	Neutral	Sad	Surprise
Anger	100	0	0	0	0	0	0
Disgust	0	100	0	0	0	0	0
Fear	0	20	0	60	0	20	0
Happy	0	0	0	100	0	0	0
Neutral	0	0	0	0	100	0	0
Sad	0	0	0	0	20	80	0
Surprise	60	20	0	0	0	20	0

Figure 4. Tested Image Vs Recognized Image

Table II shows the overall confusion matrix on the whole testing dataset. Each confusion matrix shows the true emotion label (vertical) versus the classification results (horizontal). Figure 4 shows few example of confusion matrix, where it is shown that how fear expression is confused with sad, happy and disgust expression. In another example it shows that surprise expression confused with anger expression.

V. CONCLUSION

In this paper the particular method using Principal Component Analysis for facial expression detection was initially started with 50 training images and 35 testing images from each class of expression. After that the same procedure was repeated by increasing the number of

training images from each class of expression and decreasing the number of testing images. The principal components are selected for each class independently to reduce the eigenspace. With these eigenvectors the input test images were classified based on Euclidian distance. The proposed PCA method has the greater accuracy with consistency. The recognition rate was greater even with the small number of training images which demonstrated that it is fast, relatively simple, and works well in a constrained environment.

VI. References

[1] A. S. Tolba; A.H. El-Baz; A.A. El-Harby:"Face Recognition: A Literature Review," World Academy of Science, Engineering and Technology 2006.

[2] M. Turk, A. Pentland, Eigenfaces for Recognition, Journal of Cognitive Neurosicence, Vol. 3, No. 1,1991, pp. 71-86.

[3] F. Wallhoff, "Facial Expressions and Emotion Database http://www.mmk.ei.tum.de/~waf/fgnet/feedtum.html," *Technische Universität München*, 2006

[4] Mehrabian, A." Communication without words", *Psychology Today vol.2,no.4*, pp.53–56,1968.

[5] Jyh-Yeong Chang and Jia-Lin Chen, "Automated Facial Expression Recognition System Using Neural Networks" Journal of the Chinese Institute of Engineers, Vol. 24, No. 3, pp. 345-356 (2001).

[6] Ekman, P., Friesen, "the Facial Action Coding System", W.V., 1978, Consulting Psychologist Press, San Francisco, CA.

[7] Manal Abdullah1, Majda Wazzan1 and Sahar Bo-saeed "Optimizing Face Recognition Using PCA" International Journal of Artificial Intelligence & Applications (IJAIA), Vol.3, No.2, March 2012.

[8] G. R. S. Murthy, R.S.Jadon "Effectiveness of Eigenspaces for Facial Expressions Recognition" International Journal of Computer Theory and Engineering, Vol. 1, No. 5, December, 2009, pp. 1793-8201.

[9] Kanade, T., Cohn, J.F., & Tian. "Comprehensive Database for Facial Expression Analysis" Proceedings of the Fourth IEEE International Conference on AFGR (FG"00). Grenoble, France, 2000.

[10] Lyons, M. Akamatsu, S. Kamachi, M. Gyoba, J. "Coding facial expressions withGabor wavelets", Proceedings of the 3rd IEEE Int. Conf. on AFGR, Nara, Japan, pp 200-205, 1998.