International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-2 Issue-5, June 2013

A Novel Approach for Facial Expression Recognition Using Euclidean Distances

Annu, Chander Kant

Abstract*—There has been a growing interest in automatic face and facial expression recognition from facial images due to a variety of potential applications in law enforcement, security control, and human computer interaction. However, despite of all the advances in automatic facial expression recognition, it still remains a challenging problem. This paper describes an idea of recognizing the human face even in the presence of strong facial expressions using the Eigen face method. The features extracted from the face image sequences can be efficiently used for face and facial expression recognition. Firstly, we compute the Eigen value and Eigen vectors of the input image and then finally the input facial image was recognized when similarity was obtained by calculating the minimum Euclidean distance between the input image and the different expressions.

Keywords*—Eigen face, Eigen value, Euclidean distance, facial expression recognition, facial features, face recognition.

I. INTRODUCTION

Since last three decades of face recognition technology, there exists many commercially available systems to identify human faces, however face recognition is still an outstanding challenging problem. This challenge can be attributed to (i) large intra-subject variations such as pose, illumination, expression, and aging is commonly encountered in face recognition and (ii) large inter-user similarity. Meanwhile this technology has extended its role to Human-Computer-Interaction (HCI) and Human-Robot-Interaction (HRI). Person identity is one of the key tasks while interacting with the robots, exploiting the un-attentional system security and authentication of the human interacting with the system. This problem has been addressed in various scenarios by researchers resulting in commercially available face recognition systems [1,2]. However, other higher level applications like facial expression recognition and face tracking still remain outstanding problem along with person identity. This gives rise to an idea for generating a framework suitable for solving these issues together.

A. Facial Action Coding System

A fully automatic facial action coding system was developed using action units which is a user independent fully automatic system for real time recognition of facial actions.

Manuscript published on 30 June 2013.
***** Correspondence Author (s)
Annu, M.Tech student, DCSA, KUK, kurukshetra, have published two more papers except this paper.
Dr. Chander Kant Verma, Assistant professor, DCSA, KUK, Kurukshetra. He is P.hd. in field of biometrics from DCSA, KUK. He is on the role of editor chief in IJITKM, associate editor in IJCSC and in IJEE. He is also member of editorial board in IJCA, IJSC, IJISP and IJCIRP.

Ekman and Friesen (1976, 1978) were pioneers in the development of measurement systems for facial expression. Their system, known as the Facial Action Coding System or FACS, was developed based on a discrete emotions theoretical perspective and is designed to measure specific facial muscle movements which is shown in figure 1. A second system, EMFACS, is an abbreviated version of FACS that assesses only those muscle movements believed to be associated with emotional expressions. In developing these systems, Ekman importantly distinguishes between two different types of judgments: those made about behavior (measuring sign vehicles) and those that make inferences about behavior (message judgments). Ekman has argued that measuring specific facial muscle movements (referred to as action units in FACS) is a descriptive analysis of behavior, whereas measuring facial expressions such as anger or happiness is an inferential process whereby assumptions about underlying psychological states are made.

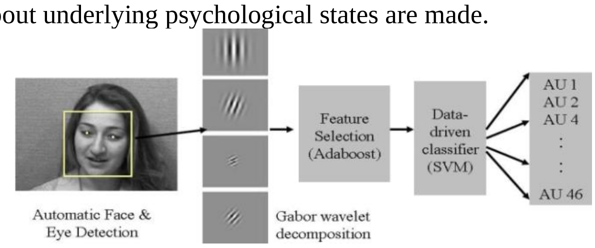

Figure 1: Facial action coding system

In this system following steps are considered to extract the expressions-

1. Firstly, automatic system is used to detect the face and then the Pain Expression from an image.
2. Then Gabor filter is applied on the extracted face and Pain Expression. This filter is used in image processing for edge detection.
3. The selected edges are passed through adaboost (adaptive boosting) to select the desired features.
4. Then Eigen face (support vector machine) is used to classify the features and arrange them into action units.
5. The action units are then used to classify different features.

II. RELATED WORK

A formal method of classifying the faces was first proposed by Francis Galton [2] in 1888. Galton proposed collecting facial profiles as curves, finding their norm, and then classifying other profiles by their deviations from the norm. The classification was resulting in a vector of independent measure that could be compared with other vectors in the database.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Traditional recognition systems have the abilities to recognize the human using various techniques like feature based recognition, face geometry based recognition, classifier design and model based methods. Linear subspace methods like Principal Components Analysis (PCA) was firstly used by Sirvovich and Kirby [3], which were latterly adopted by M. Turk and A. Pentland introducing the famous idea of Eigen faces [4,5]. Murthy and Jadon [6] enhanced this method to recognize the expression from the front view of the face, tested for the Cohn-Kanade (CK) Facial Expression database and Japanese female facial expression (JAFFE) database. Zhi, Flierl, Ruan, and Kleijn [7] applied the projected gradient method and developed the graph-preserving sparse non-negative matrix factorization (GSNMF) for extraction of feature verified on different databases. Ma and Khorasani [8] extended this image compression with the constructive one hidden layer neural network with the optimal block size to be 12 and the maximum number of hidden units to be 6, thus achieving the accuracy rate of nearly 93.75%. Researchers have also used the MPEG-4 standard to provide the facial action parameters (FAPs) to represent the facial expressions. Aleksic and Katsaggelos [9] developed a facial expression recognition system utilizing these facial action parameters basically describing the eyebrow and the outer lip features, and classifying up to 93.66% of the test expressions by calculating the maximum likelihoods generated by the multistream hidden Markov model (MS-HMM). Huang and He [10] presented a super resolution method to improve the face recognition of low resolution images. The type of models using shape and texture parameters are called Active Appearance Models (AAMs), introduced by Edwards and Cootes. However, Edwards et al isolated the sources of variation by maximizing the interclass variations using Linear Discriminant Analysis (LDA), the technique which was holistically used for Fisher faces representation which is similar to the Eigen face approach resulting in out performance of previous approach. Gao, Leung, Hui, and Tananda [11] used the line based caricature of the facial expression for the line edge map (LEM) descriptor, measuring the line segment Hausdorff distance between the line caricature of the expression and the LEM of the test face. They achieved an optimal value of 86.6%, showing that the average recognition rate of females was 7.8% higher than that of males. In view of the color features, Lajevardi and Wu [12] presented a tensor based representation of the static color images. They achieved 68.8% accuracy at recognizing expression with different resolutions in CIEluv color space.

III. PROPOSED WORK

In our proposed work, Face and Facial Expression detection is presented by combining the Eigen value and Eigen face methods which perform almost as fast as the Eigen face method but with a significant improved speed.

A. Algorithm of The Proposed Approach

The proposed work is divided into 3 main stages:

1. Preprocessing
2. Training the Dataset
3. Matching

The image preprocessing work mainly consists of four different modules, namely, histogram equalization, edge detection, thinning, and token generation. The face image is taken as an input and tokens are produced as output. It includes the conversion of image to the normalized image as well as to extract the features from the image. The filtration process includes the adjustment of brightness, contrast, low pass, high pass filtration etc. The filtration will be done in two phases one for face and other for facial expression. To enhance the image quality, histogram equalization has been performed.

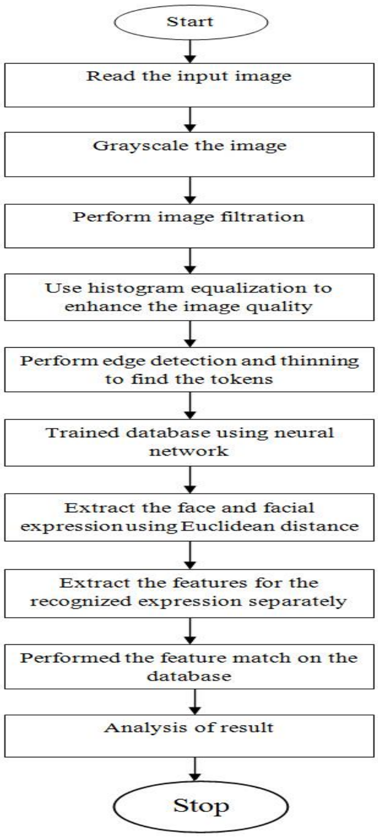

Figure 2: Flow Chart of the proposed approach

It is then followed by the edge detection process. Edge detection plays an important role in finding out the tokens. It is a terminology in image processing, particularly in the areas of feature detection and feature extraction, which aims at identifying points in a digital image at which the image brightness changes sharply or more formally have discontinuities. After the edge detection, thinning has to be performed. It is applied to reduce the width of an edge to single line. After the thinning process, tokens have been generated. Tokens divide a data set in to the smallest unit of information used for subsequent processing.

Another task is performed on the available database. The database will be trained by using Neural Network. The training module stores the token information that comes from the image pre-processing module. It can be done using any method. Here, neural network is used. The power of neural networks is realized when a pattern of tokens, during testing, is given as an input and it identifies the matching pattern it has already learned during training. The training process will be done only once and after training a feature analysis based database will be created. The actual match will be performed on this Eigen Face trained dataset.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Again we have to generate two datasets one for the face itself and the other for the Facial Expression. Flow chart of the proposed approach is shown in figure 2.

Third and the final step is to perform the match. The match will be performed on both the face image and the Facial Expression image separately. If both matches give the results better than the expected value then the person will be identified.

B. Eigen Face Method

The motivation behind Eigen faces is that it reduces the dimensionality of the training set, leaving only those features that are critical for face recognition.

IV. DEFINITION

1. The Eigen faces method looks at the face as a whole.
2. In this method, a collection of face images is used to generate a 2-D gray-scale image to produce the biometric template.
3. Here, first the face images are processed by the face detector. Then we calculate the Eigen faces from the training set, keeping only the highest Eigen values.
4. Finally we calculate the corresponding location in weight space for each known individual, by projecting their face images onto the “face space”.

In mathematical terms, the objective is to find the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images. These eigenvectors can be thought of as a set of features which together characterize the variation between face images. Each image location contributes more or less to each eigenvector, so that we can display the eigenvector as a sort of ghostly face called an Eigen face.

Each face image in the training set can be represented exactly in terms of a linear combination of the Eigen faces. The number of possible Eigen faces is equal to the number of face images in the training set. However, the faces can also be approximated using only the “best” Eigen faces—those that have the largest Eigen values, and which therefore account for the most variance within the set of face images. The primary reason for using fewer Eigen faces is computational efficiency. The most meaningful *M* Eigen faces span an *M*-dimensional subspace—“face space”—of all possible images. The Eigen faces are essentially the basis vectors of the Eigen face decomposition. The idea of using Eigen faces was motivated by a technique for efficiently representing pictures of faces using principal component analysis.

The Eigen faces approach for face recognition involves the following initialization operations:

1. Acquire a set of training images.
2. Calculate the Eigen faces from the training set, keeping only the best *M* images with the highest Eigen values. These *M* images define the “face space”. As new faces are experienced, the Eigen faces can be updated.
3. Calculate the corresponding distribution in *M*-dimensional weight space for each known individual (training image), by projecting their face images onto the face space.

Having initialized the system, the following steps are used to recognize new face images:

1. Given an image to be recognized, calculate a set of weights of the *M* Eigen faces by projecting the it onto each of the Eigen faces.
2. Determine if the image is a face at all by checking to see if the image is sufficiently close to the face space.
3. If it is a face, classify the weight pattern as either a known person or as unknown.
4. (Optional) Update the Eigen faces and/or weight patterns.
5. (Optional) Calculate the characteristic weight pattern of the new face image, and incorporate into the known faces.

C. CALCULATING EIGEN FACES

Let a face image Γ(x,y) be a two-dimensional *N* by *N* array of intensity values. An image may also be considered as a vector of dimension N^2, so that a typical image of size 256 by 256 becomes a vector of dimension 65,536, or equivalently, a point in 65,536-dimensional space. An ensemble of images, then, maps to a collection of points in this huge space.

Images of faces, being similar in overall configuration, will not be randomly distributed in this huge image space and thus can be described by a relatively low dimensional subspace. The main idea of the principal component analysis is to find the vector that best account for the distribution of face images within the entire image space. These vectors define the subspace of face images, which we call “face space”. Each vector is of length N^2, describes an *N* by *N* image, and is a linear combination of the original face images. Because these vectors are the eigenvectors of the covariance matrix corresponding to the original face images, and because they are face-like in appearance, they are referred to as “Eigen faces”.

1. The first step is to obtain a set S with M face images. Each image is transformed into a vector of size N and placed into the set.
2. Get the Input Image I.
3. Normalized the Image Set S as to get it in required format.
4. Calculate the Mean Image from Set S.
5. Find the Difference between the Mean Image and the Input Image I.
    I. D=Mean-Input Image
6. Find the Orthogonal Vectors of the image that describe the image in better way.
7. Calculate the Eigen Values and Eigen vectors for the image.
8. Find the Covariance Matrix for the image.
9. Find the Image Set with lower Euclidean distance.
10. Reperform the Operation on this image set with lower threshold value to get the image having the expression closer to the defined image.
11. The image with lowest Euclidean distance in expression images will be represented as the resultant expression image.

V. CONCLUSION AND FUTURE WORK

The presented system is a multimodal architecture in which the detection of a person is performed on the basis of face and the Facial Expression values. The user will have to provide the input in the form of face image and the comparison will be performed on both the face and the Facial Expression images.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

To perform the recognition process the PCA and the EIGENFACE approach is used collectively.The basic steps of recognition are same as some existing approach. Here we have providing an approach to use combination of approaches to identify the face and Facial Expression images. The present work can be extended by researchers in different direction. The foremost process is to improve the identification approach by using some neural or the fuzzy based analysis. The another improvement can be done to replace the face recognition using facial feature recognition and facial Expression detection by radial curvature detection.

VI. ACKNOWLEDGMENT

I would like to express my deep sense of indebtedness and sincerest gratitude to Dr. Chander Kant Verma for his in - valuable guidance and appreciation throughout the work.

REFERENCES

1. W. Zhao, R. Chellapa, A. Rosenfeld and P.J. Philips, "Face Recognition: A Literature Survey", UMD CFAR Technical Report CAR-TR-948, 2000.
2. William A. Barrett, "A Survey of Face Recognition Algorithms and Testing Results", Proceeding of IEEE, 1998.
3. L. Sirovich and M. Kirby, "Low-dimensional procedure for the characterization of human faces", J. Opt. Soc. Am. A, Vol. 4, No. 3, March 1987, pp 519-524.
4. Turk M.A., Pentland A.P., "Face Recognition using Eigenfaces", IEEE Conference on Computer Vision and Pattern Recognition, 1991, pp 586-591.
5. Turk M.A., Pentland A.P., "Eigenfaces for Recognition", Journal of Cognitive Neuroscience 3 (1): 1991, pp 71-86.
6. G. R. S. Murthy and R. S. Jadon, "Effectiveness of Eigenspaces for Facial Expressions Recognition" International Journal of Computer Theory and Engineering, vol. 1, no. 5, pp. 638-642, December 2009.
7. R. Zhi, M. Flierl, Q. Ruan, and W. B. Kleijn, "Graph-Preserving Sparse Nonnegative Matrix Factorization with Application to Facial Expression Recognition", IEEE Transactions on Systems, Man and Cybernetics—Part B: Cybernetics, vol.41, no. 1 pp. 38-52, February 2011.
8. L. Ma and K. Khorasani, "Facial Expression Recognition Using Constructive Feedforward Neural Networks", IEEE Transactions on Systems, Man and Cybernetics—Part B: Cybernetics, vol. 34, no. 3, pp. 1588-1595, June 2004.
9. P. S. Aleksic and A. K. Katsaggelos, "Automatic Facial Expression Recognition Using Facial Animation Parameters and Multistream HMMs", IEEE Transactions on Information Forensics and Security, vol. 1, no. 1, pp. 3-11, March 2006.
10. H. Huang and H. He, "Super-Resolution Method for Face Recognition Using Nonlinear Mappings on Coherent Features", IEEE Transactions on Neural Networks, vol. 22, no. 1, pp. 121-130, January 2011.
11. Y. Gao, M. K. H. Leung, S. C. Hui, and M. W. Tananda, " Facial Expression Recognition From Line-Based Caricatures" IEEE Transactions on Systems, Man and Cybernetics-Part A:Systems and Humans, vol. 33, no. 3, pp. 407-411, May 2003.
12. S. M. Lajevardi and H. R. Wu, "Facial Expression Recognition in Perceptual Color Space" IEEE Transactions on Image Processing, vol. 21, no. 8, pp. 3721-3732, August 2012.

Annu, M. Tech. student, DCSA, KUK, Kurukshetra, have published two more papers except this paper.

Dr.Chander kant verma, Assistant professor, DCSA, KUK, kurukshetra.He is phd in field of biometrics from DCSA, kuk. He is on the role of editor chief in IJITKM, associate editor in IJCSC and in IJEE. He is also member of editoral board in IJCA, IJSC, IJISP and IJCIRP.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)