Facial Expression Recognition using PCA-RBFNN Method and Local Feature Extraction

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Abstract— Facial Expression Recognition is still standing out amongst the most difficult issues in biometric systems. In this study, we implement Facial Expression Recognition using Principal component analysis (PCA) and Radial Basis Function Neural network (RBFNN) approach. We extract facial expression features using local method. The proposed system works in three parts. First Pre-processing: where median filtering is done to make faces prepared for feature extraction, then Feature extraction: where local features (Entropy, Mean, Standard Deviation and Euler coefficient) based projection elements are extracted which are utilized to recognize the distinctive faces. In the experimental results, we improved facial expression recognition accuracy in terms of recognition rate is 99.53% with database of JAFFEE (84 faces of 12 persons).

Key words: Facial Expression Recognition, PCA, Local Feature, Radial Basis Function Neural Network, Median Filtering

I. INTRODUCTION

In the present time of computer implemented machine civilization, many kind of machine systems or equipments offering services to human beings have been indispensable for leading our daily life, with increasing tendency in future. In fact not only the machine computational speed but also machine intelligence is playing an important role. It is argued that computer to be able to interact with human beings, it need to have ability to understand the emotional state of a person. Facial expression is the greatest channel for recognition of emotion and creation machine intelligent. Hence a concept of AHI is emerged as a new paradigm for developing the technology to realize communication between human beings and intelligent machine [2]. As Mehrabian reported that message transfer of spoken words is only 7%, voice information 38% and facial expression 55%, it has become crucial to use facial expression as a message transfer media between human beings and intelligent machine.

The recognition of facial expression has become one of the most popular research topic in human computer interface (HCI). During the last decades, many facial expression recognition methods had been proposed in the literatures. Most of the methods target at classifying all facial image into one of the six main emotion types, i.e., happy, sad, disgust, surprise, fear and angry, defined by Ekman and Friesen [3]. In some cases, one may be interested in recognizing the intensity of all six basic emotions instead of just knowing the main emotion category to which a facial image is to be classified. Linear regression is a widely used approach to this goal. To make the linear regression approach more appropriate to describe the relationship between facial expression service vectors and corresponding semantic feature vectors, it is useful to perform the feature extraction processing before applying the linear regression approach, such that the extracted facial expression features and the corresponding semantic features are linearly correlated, where the semantic features represent the degree of class membership of the facial image associated with the six basic emotions.

II. LITERATURE SURVEY

Steven Lawrence (2013) et al present that ICA is a recent approach for dimensionality reduction. Locality Preserving Projections (LPP) is also a recently proposed new method in pattern recognition for feature extraction and dimension reduction. developed and analyzed the face recognition rate of ICA and LPP under varying illuminations and facial express ions. Analyzes is performed on Y ALEB databases which contains 64 illuminations conditions (5760 images) and ATT databases which contains major facial expressions (400 images) [4].

Xiaoyan Zhou (2012)et al present that a new CCA algorithm for recognition of facial expression. In the contrast to classical algorithm of CCA, the proposed technique is capable of choosing the optimal spectral components of the training information matrix in modeling the linear correlation between corresponding expression class membership vectors and the facial feature vectors. To identify the emotion each category facial image, present a linear regression formula to predict the emotion class membership for all facial image. The experiments on the JAFFE facial expression database confirm the improved recognition performance of the proposed technique [5].

Wei Li (2015) et al present a deep-learning based method applying CNNs. In order to assess performance in the real-time candid facial expression recognition, created CIFE dataset, with expression of seven kinds in more than 10,000 images gathered from the Web. As baselines, two different feature-based methods (LBP+SVM, SIFT+SVM) are tested on the dataset. CNN-based method is defined, and an information augmentation method is provided in order to create sufficient number of training samples. The performance applying the feature-based methods is close to the art state when tested with standard datasets, but fails to function well when dealing with candid images[6].

JalilMazloum (2012) et al present new bidirectional architecture for face recognition inspired through human system of face recognition is presented via using inversion in ANN's. In this method, stored information in the inverse network is applied in the recognition system iteratively and then the face recognition correctness model has been consequently better through 8%.The proposed model is able to produce 12 numerous facial expressions on the output, from only one input expression of all person, after training with AUT database images [7]**.**

Nagaraja S. (2014) et al present that technique for facial expression representation based on extraction of

Robust Local Binary Pattern (RLBP) features in curvelet domain. The proposed technique is evaluated based on recognition of facial expression carried out applying a benchmark database for example JAFFE. The recognition of facial expression is performed applying a chi-square distance measure with a nearest neighbor classifier[8].

EndangSetyati (2012) et al presents that a facial emotion expressions recognizing technique based on the ASM and RBFN (Radial Basis Function Network). ASM (Active Shape Model) is one of the most famous approaches for facial feature\ extraction. The accuracy of ASM depends on various factors, for example image sharpness, brightness, and noise[9].

ChunnaTian (2012) et al present that view-manifold-based TensorFace (V-TensorFace), in which the latent view manifold preserves the local distances in the multiview face space. a unified framework to generalize Tensor- Face, V-TensorFace, and K-TensorFace. Finally, an expectation maximization like algorithm is developed to estimate the identity and view parameters iteratively for a face image of an unknown/unseen view[10].

III. PROPOSED METHODOLOGY

In image or picture representation one is concerned with the characterization of the amount that every picture-element (likewise called pixel) indicates.

The input facial expression image as indicated in Fig 2 is acquired by scanning expression of the individual, which is further preprocessed to make expression images standard and ready for feature extraction. In the pre-processing stage image is first, apply median filtering for removing noise from an image to make feature extraction simple in Fig 3.

Principal component Analysis (PCA) technique is utilized for signature recognition. The purpose behind PCA is to decrease the hugged imensionality of the data space to the littler natural dimensionality of the element space (autonomous variables), which are expected to explain the information economically. It is realized that the independent variable is liable to the same amount of deviation or error as the needy variable.

A. Proposed Algorithm

1) Processing of the face consists into two stages: Training phase and Testing phase.
2) Take train database images which contain 84 images of 12 persons and test database which contain 42 images.
3) In the preprocessing step, apply a median filter for removing noise from an image.
4) In the feature extraction process, extract features of an image using local features (entropy, mean, standard deviation and euler coefficient).
5) Repeat step 3 to 4 until all train and test images processing is completed.
6) In the classification process, apply radial basis function and principal component analysis.
7) A picture of size MxM can be represented as a point in a M2 dimensional space. Given a face picture I(x, y), be two dimensional M by cluster of (8 bit) intensity value. N training pictures are represented by I1, I2,…., IM and every picture Ii is represented to as a vector Fi. Presently the normal face vector is figured utilizing the accompanying comparison.

$$\varphi = \frac{1}{N}\sum_{i=1}^{N} Fi$$

Here, φ is the average face vector. Now the deviation is estimated from the mean (average) face vector for every image. The equation will be as follows:

$$\emptyset i = Fi - \varphi$$

$$A=[\emptyset 1, \emptyset 2 \ldots \emptyset N]$$

Here, $\emptyset i$ is the deviation vector for ith image. A is the set of deviation vector of N images. We can compute the covariance using A vector as

$$D = AA^T$$

Here D is an M2xM2 matrix and A is an M2xN matrix. In place of matrix AA^T, we study the matrix A^TA. Remember A is a M2xN matrix, thus A^TA is an NxN matrix. If we calculate the Eigenvectors of this matrix, it would return N Eigenvectors, each of dimensions Nx1, let's call these Eigenvectors v_i. The best N Eigenvectors can be detected with the help of below equation:

$$\mu_i = Av_i$$

8) Each face in the preparation set (short the mean), $\emptyset i$ can be spoken to as a straight gathering of Eigenvectors μi.

$$\emptyset i = \sum_{k=1}^{j} \omega k \mu_k$$

9) These weights can be considered as:

$$\omega_k = \mu_i^T \emptyset i$$

10) Every normalized training image is characterized on this basis as a vector

$$\omega_i = \omega_1, \omega_2 \ldots \omega_j$$

Processing of signature consists of two main stages:

- Training stage
- Testing stage

In the examination of the proposed strategy, 84 facial expressions of 12 persons for training phase and for testing phase, we taken 42 images of 12 persons are utilized to prepare the system.

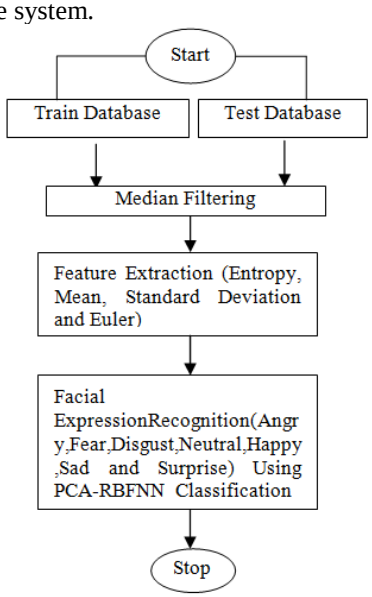


Fig. 1: Proposed System Block Diagram

In the recognition process, Radial Basis Function Neural Network is designed and implemented using MATLAB 12a. There are numerous algorithms that can be used to create neural network, but the RBFNN is chosen as it

is easiest to implement, while preserving efficiency of the network. Neural Network consists of simple computational elements known as neurons, which are linked with weights. It generally consists of 3 layers: the input layer, hidden layer and the output layer. The first layer takes the inputs while last one producing the outputs. The middle (hidden) layer has no connection with the external world, and hence is called hidden layers. It serves as a propagation point for sending data from the previous layer to the next layer.

In table1, we are evaluating texture features using performance indices such as accuracy, texture based measures (Entropy, Mean, Standard Deviation and Euler number).

1) Image Dataset for Train images

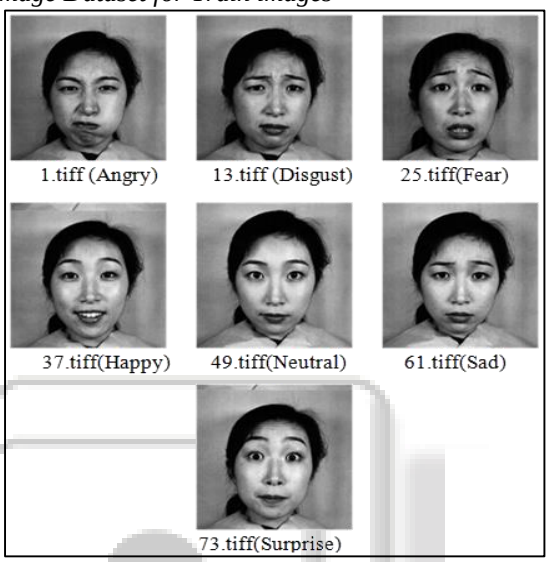


Fig. 2: Jaffee Database with 12 Females

2) Preprocessing Step for Test Images

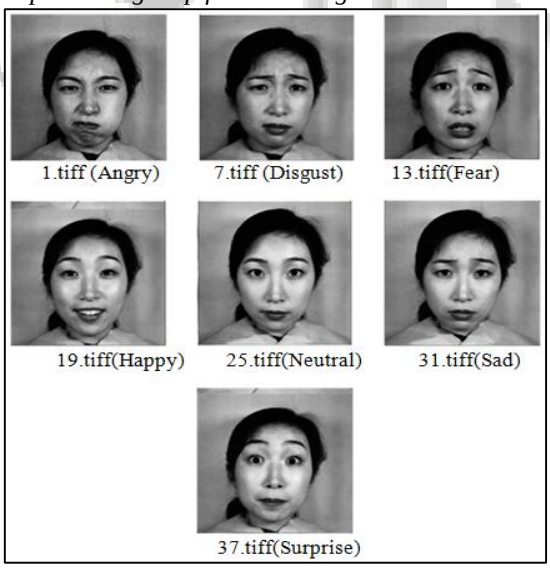


Fig. 3: Show Filtered Images

IV. COMPARATIVE RESULTS

A. MATLAB:

MATLAB is a data visualization and analysis tool which has been designed with powerful support for matrix and matrices operations. Along with this, Matlab has capabilities of excellent graphics, and its own powerful programming language. One of the reasons that Matlab has become such an important tool is by the use of Matlab programs designed sets to support a specific task. These programs sets are known as toolboxes, and the specific interest toolbox to us is the image processing toolbox.

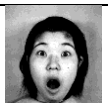
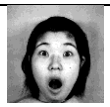
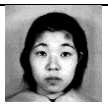
Test Image	Expression	Distance	Match Test Image with Train Image	Accuracy (%)
 10.tiff	Disgust	8071	 19.tiff	99.36
 11.tiff	Disgust	5795	 21.tiff	99.53
 16.tiff	Fear	9444	 31.tiff	99.45
 13.tiff	Fear	5848	 25.tiff	99.60
 2.tiff	Angry	6398	 3.tiff	99.62
 4.tiff	Angry	7117	 7.tiff	99.48
 41.tiff	Surprise	5336	 81.tiff	99.66
 39.tiff	Surprise	8930	 77.tiff	99.34
 35.tiff	Sad	4920	 69.tiff	99.43
 31.tiff	Sad	5583	 61.tiff	99.41
 30.tiff	Neutral	6503	 59.tiff	99.51
 27.tiff	Neutral	7930	 53.tiff	99.64

Table 1: Show Matched Image with Test Image and Expression

Algorithm	Average MAE	Average MSE	Average Recognition Rate	Execution Time
Base	0.1820	0.0594	94.28%	35.76
Proposed	0.0119	0.0533	99.53%	8.343

Table 2: Comparison Between Base and Proposed System

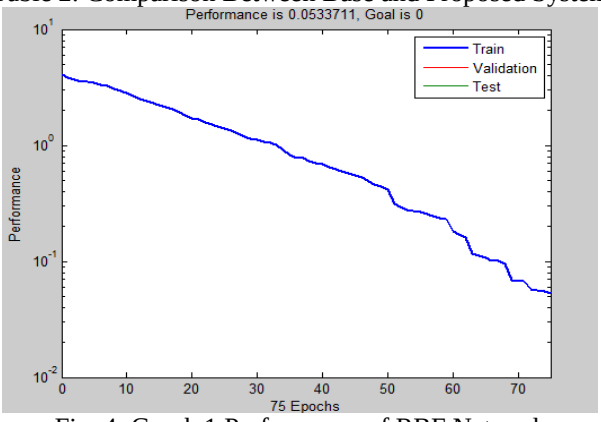


Fig. 4: Graph 1.Perfprmance of RBF Network

V. CONCLUSION

In this paper, we implement Facial Expression Recognition using Principal component analysis (PCA) and Radial Basis Function Neural network (RBFNN) approach. The proposed system has used a texture based technique (local feature) for feature extraction and RBFNN as a classifier to recognize the expression. It has been observed that the features extracted using entropy, along with mean, standard deviation and euler number are found to be efficient for facial expression recognition. We achieved the accuracy rate ranging from 90%-100% for enrollment of 12 persons. We achieved a 99 % classification result for all principal emotions along with Neutral on testing data set and 100% results for Angry, Disgusts, Fear, Happy, Neutral and Sad. The recognition result for surprise emotion is 99%.The average accuracy is 99.53% for testing data.Future work of this work includes the analyses of the new features of expression image and combining those with the feature vectors used in this work to obtain better accuracy than the accuracy of the present works.

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