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A Hybrid Framework of Facial Expression Recognition using SVD & PCA

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Abstract-Facial Expression Recognition (FER) is really a speedily growing and an ever green research field in the region of Computer Vision, Artificial Intelligent and Automation. This paper implements facial expression recognition techniques using Principal Component analysis (PCA) with Singular Value Decomposition (SVD). Experiments are performed using Real database images. Support Vector Machine (SVM) classifier is used for face classification. Emotion detection is performed using Regression Algorithm with SURF (Speed Up Robust Feature).The universally accepted five principal emotions to be recognized are: Angry, Happy, Sad, Disgust and Surprise along with neutral.

Keywords-SVD, PCA, SURF, Facial expression, Accuracy

I.INTRODUCTION

Expression is an important mode of non-verbal conversation among people. Recently, the facial expression recognition technology attracts more and more attention with people's growing interesting in expression information. Facial expression provides essential information about the mental, emotive and in many cases even physical states of the conversation. Face expression recognition possesses practically significant importance; it offers vast application prospects, such as user-friendly interface between people and machine, humanistic design of products, and an automatic robot for example. Face perception is an important component of human knowledge. Faces contain much information about ones id and also about mood and state of mind. Facial expression interactions usually relevant in social life, teacher-student interaction, credibility in numerous contexts, medicine etc. however people can easily recognize facial expression easily, but it is quite hard for a machine to do this.

To achieve high degree of efficiency, to increase the speed of computation, better utilization of memory, in terms of classification and recognition of facial expressions by some of the modifications in terms of feature extraction, classification and recognition algorithms. To meet the estimated goals, the main objective of this research is to develop Facial Expression Recognition System by combination of two or more techniques that can take human facial images having some expression as input, classify and recognize them into appropriate expression class that we are using.

Principal Components Analysis (PCA) is a technique of identifying patterns in data, and expressing the data in such a way so as to highlight their differences and similarities [1]. *Singular Value Decomposition* is an outcome of linear algebra. This plays an interesting, essential role in many different apps.

One such applications is in digital image Processing. SVD in digital applications provides a robust method for storing large images into smaller and more manageable square ones [2].SURF (Speed Up Robust Feature) is a Robust local feature detector . This SURF detector is based on the determinant of Hessian matrix.

II.FACIAL EXPRESSION DATABASE

The database obtained with 50 photographs of one person at different expression. There are 50 images in database like happy, neutral, sad, anger and disgust. Database for testing phase is prepared by taking 1-5 photographs of a person on different expression but in similar conditions. such as (lighting, background, distance from camera etc.). Accuracy, Average Recognition and matching time of all test samples are obtained. Fig.1 shows the sample database image.

Fig.1 Sample Database Images

III.FACIAL EXPRESSION RECOGNITION SYSTEM

This section describes facial expression recognition system architecture. Face expression recognition system is divided into three modules: Preprocessing, Feature Extraction, Expression Recognition. Fig.2 represents the basic blocks of facial expression recognition system.

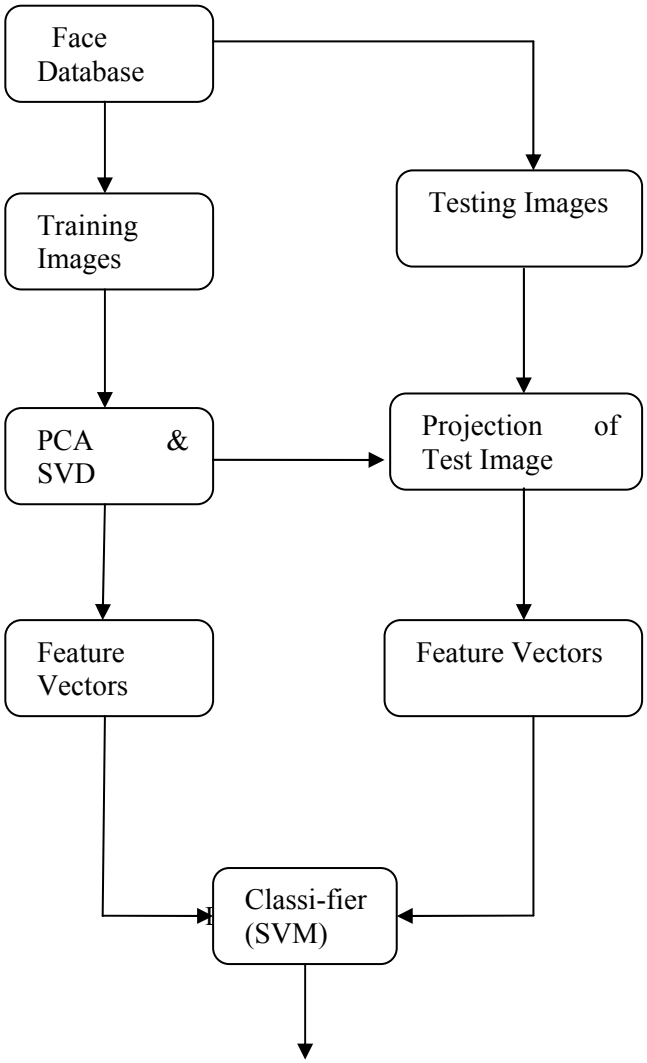

Fig.2 Facial Expression Recognition System Architecture

The images from database are uploaded and passed for Feature extraction. In feature extraction unit, feature points are extracted using PCA with SVD and point localization algorithm. The Feature matrices of train images and testing images are passed to the classifier unit for the classification of given face query with the knowledge created for the available database. Then SVM matching Classifier is used for finding the closest match. Mean of neutral images is calculated of all train images. Then distance between the expression of test image and mean neutral expression is computed that is Euclidean distance. In the same way, distance between the expression of train image and mean neutral expression is computed. The minimum difference between any pair will represent the best possible matched facial Expression. Emotion detection is then performed using Regression Algorithm with SURF feature. Accuracy, Average Recognition Rate, Matching time, PSNR and MSE are calculated for proposed work.

IV.PCA WITH SVD METHOD

Principal Component Analysis (PCA) is a statistical technique used for dimension reduction and recognition, & widely used for facial feature extraction and recognition. PCA is known as Eigen space Projection which is based on linearly projection the image space to a low Dimension feature space that is known as Eigen space.Many PCA-based face-Recognition systems have also been developed in the last decade.however ,existing PCA-based face recognition systems are hard to scale up because of the computational cost and memory requirement burden. A 2-D facial image can be reperesented as 1-D vector by concatenating each row or column into a long thin vector. Let's suppose we have M vectors of size N (= rows of image £ columns of image) representing a set of sampled images. pj's represent the pixel Values.

$$x_i = [p1, pN]^T \; ; i = 1,..... , M$$

The images are mean centered by subtracting the mean image from each image vector. Let m represent the mean image.

$$m=1/M \sum_{i=1}^{M} x_i$$

And let $w_i$be defined as mean centered image

$$w_i = x_i\text{-m}$$

Our goal is to find a set of e_i's which have the largest possible Projection onto each of the w_i's. The singular value decomposition is an outcome of linear algebra. SVD in digital applications provides a robust method of storing large images as smaller, more manageable square ones. The singular value decomposition of a matrix A of m x n matrix is given in the form,

$$A=U\Sigma VT$$

Where U is an m x m orthogonal matrix; V an n x n orthogonal matrix, and Σ is an m x n matrix containing the singular values of A along its main diagonal.

SURF METHODOLOGY

Algorithm consists of four main parts [3]. :
1) Integral image generation,
2) Fast-Hessian detector (interest point detection),
3) Descriptor orientation assignment (optional),
4) Descriptor generation.

Much of the performance in SURF can be attributed to the use of an intermediate image representation known as the Integral Image.
Integral image is used by all subsequent parts of algorithm to significantly accelerate their speed. Eq. (1) shows integral image.

$$\sum(x, y) = \sum_{i=0}^{x} \quad \sum_{j=0}^{y} I(i, j) \qquad \text{.....Eq.1}$$

The SURF detector is based on the determinant of the Hessian matrix. Based on Integral Image, we can calculate the Hessian matrix, as function of both space x = (x; y) and scale σ. Eq. (1) shows Hessian matrix [4].

$$H(x, \sigma) = \begin{bmatrix} L_{xx}(x, \sigma) & \cdots & L_{xy}(x, \sigma) \\ \vdots & \ddots & \vdots \\ L_{xy}(x, \sigma) & \cdots & L_{yy}(x, \sigma) \end{bmatrix} \quad \text{..Eq.2}$$

When SURF algorithm is used [5], all the representative points are treated with same weight. This can be accounted for by assigning dynamic weights to the representative points. Intuitively, true representative points will appear in images in the training set, and false representative points will appear rarely. Based on this intuition, the weight of each representative point can be defined as follows:

$$W_p = \frac{\text{No.of detected images w.r.t point p}}{\text{No.of training images in object}} \quad \text{..Eq.3}$$

Support Vector Machine

Support vector machines (SVM) are able to perform very effective face detection on cluttered scenes [6]. They perform structural risk minimization on training dataset to choose the best decision boundary between classes. This decision boundary is obtained from set of training data (support vectors) which are closest to the between class boundary. SVM requires a huge amount of training data to select an affective decision boundary [6] and computational cost is very high even if were strict ourselves to single pose (frontal) detection.

V.EXPERIMENTAL RESULTS

The training database is consisted of 50 images. While the test database contains 5 images that are randomly chosen for every expression. The main parameters which are used to evaluate the facial expression recognition system are: Accuracy, Average Recognition rate and matching time. The average recognition rate is 67.79. The accuracy of proposed work is 98.79. Fig. 3 reveals the comparison graph of proposed work .

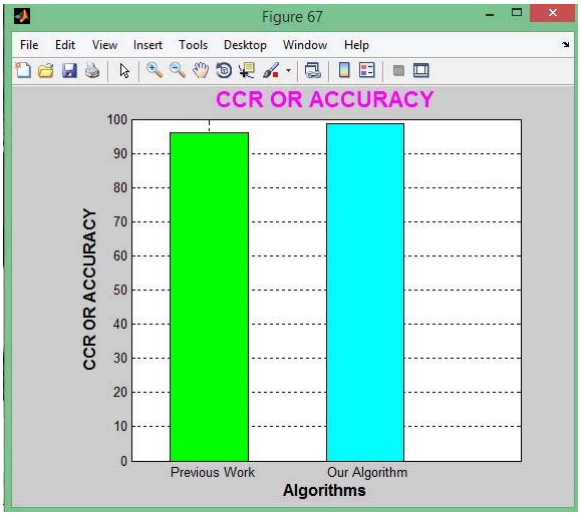

Fig.3 . Comparison graph of Accuracy of previous work and our proposed work

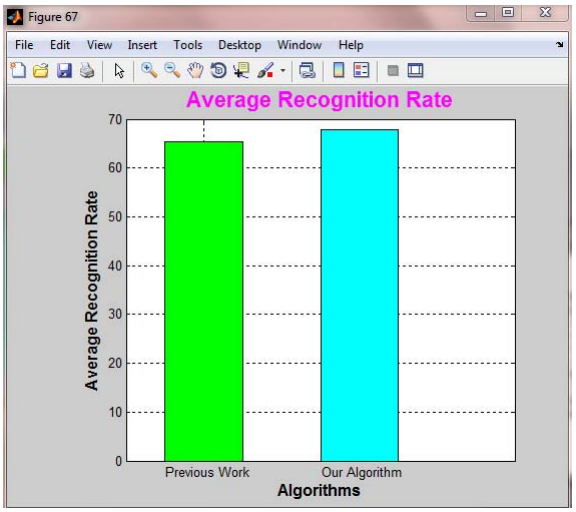

Fig.3 . Comparison graph of Average Recognition rate of previous work and our proposed work.

VI.CONCLUSION

We proposed PCA with SVD using point localization algorithm for feature points extraction. SVM is used as a classifier for classification of facial expressions and to find the closet match we use SURF feature matching technique. The algorithm is implemented on real database images captured from digital camera. This algorithm can effectively distinguish different expressions by identifying features. The Accuracy of the system obtained is about 98.79%. We got 67.79% average recognition rate for all five principal emotions namely Angry, Disgusts, Happy, Sad and Surprise along with Neutral.

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