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Face Recognition Attendance System using Eigen Vectors and PCA with Smart Phone

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ABSTRACT: Here we describe an attendance system by face recognition using Principal Component Analysis (PCA). The facial recognition part, segmentation and localization uses Viola Jones algorithm. The facial features are extracted from face image by means of Eigen Vectors. The Attendance is recorded by utilizing a camera either front / back of a smart phone catching pictures of subject, detect the face in image and contrast the distinguished appearances and the database and mark the attendance. To handle the problem of fake entry our approach uses eye blind detector. Experiments are conducted using Libor Spacek's Facial Images Databases give better performance in terms of 100% recognition rate for training set and 86.2% accuracy for test set. Thus the efficiency of the proposed method in enhancing the classification rate is high. In the end, the simulated results for the proposed technique is shown and established that proposed technique is performing better than other existing systems. The planned system is implemented using MATLAB version 9.2 R2017a and Android Studio 3.0.

KEYWORDS: Attendance System using Face recognition, Eigen Vectors, Face regions, Feature extraction, PCA

I. INTRODUCTION

Facial recognition, an important task in human computer interaction can be achieved in this work. We investigate how to recognize facial features automatically. Feature based Facial recognition uses three steps such as face detection, feature extraction and matching the face with the face in the database. To recognize facial expressions from the image, a set of key facial parameters that best describe the particular set of facial feature needs to be extracted from the face image so that it can be used to distinguish among expressions from the given dataset. This group of key parameters is called the "Feature Vector" of the image and the amount of information extracted from the image to the feature vector is the single most important factor of successful feature extraction technique.

There are different kinds of methods to extract feature vector from facial images such as DCT [1], wavelet [1], LBP [3],[12], PCA [4] and Gabor methods, amid Gabor features have been used widely after Lyons et al. [5] first projected that the Gabor representation shows a major degree of emotional plausibility. Due to this our work uses PCA for feature extraction from face image. Our conclusion points to that it is achievable to build a improved automatic facial recognition system based on a PCA.

II. RELATED WORK

Many approaches have been worked out for Facial Recognition Attendance System. Samuel Lukas [1], et al. designed a method for attendance system using face recognition technique with the combination of Discrete Wavelet Transforms (DWT) and Discrete Cosine Transform (DCT) which extracted the features of student's face by applying Radial Basis Function (RBF) for classifying the facial elements.

Marko Arsenovic et.al [10] developed a Deep learning based face recognition attendance system. It uses CNN cascade for face detection and for generating face embedding. The overall accuracy was 95.02% on a small dataset of the original face images of employees in the real-time environment. The proposed face recognition model could be integrated in another system with or without some minor alternations as a supporting or a main component

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for monitoring purposes.

Soniya V et al., [8] (2017) has developed a system automatically detects the student's entry in the class and marks attendance for the particular student periodically. The data collected can be used by the system further for attendance score calculation and other managerial decisions. Arduino is used to create and control the system that could automatically mark the attendance for the students.

Nazare Kanchan Jayant et al.,[7] (2016) has developed a system that employs modified version of Viola-Jones algorithm for face detection, and alignment- free partial face recognition algorithm for facial recognition. After successful recognition of a student, the system automatically updates the attendance in the excel sheet. The system developed by them improves the performance of existing systems by avoiding any inconsistencies, proxy marking and entry of attendance in institutional websites.

S. L. Happy et al., [11] proposed a novel framework where few prominent facial patches, depending on the position of facial landmarks, are extracted which are active during emotion elicitation. These active patches are further processed to obtain the salient patches which contain discriminative features for classification of each pair of expressions, thereby selecting different facial patches as salient for different pair of expression classes. One-against-one classification method is adopted using these features.

Maja Pantic et al. [2] presented multi detector approach to facial feature localization to spatially sample the profile contour and the contours of the facial components such as the eyes and the mouth. From the extracted contours of the facial features, they extracted ten profile-contour fiducial points and 19 fiducial points of the contours of the facial components. Based on these, 32 individual facial muscle actions (AUs) occurring alone or in combination are recognized using rule-based reasoning.

L. Lei, S. w. Kim et al.[14] presented a novel feature descriptor Eigen Directional Bit-Plane (EDBP) which is obtained by decomposing Local Binary Pattern (LBP) into 8 directional bit-planes (DBP), each of which represents certain directional information of the facial image. Principal Component Analysis (PCA) was then applied to the DBP space to obtain a more compact feature, the EDBP.

Muge Carkı et al. [15] presented Eigen faces method is for face recognition. In the recognition process, an eigen face is formed for the given face image, and the Euclidian distances between this eigen face and the previously stored eigen faces are calculated. The eigen face with the smallest Euclidian distance is the one the person resembles the most.

III. PROPOSED SYSTEM DESIGN

Figure 3.1 shows the outline of the system design. The procedure of the entire system consists of four parts

a. Image Capture and Pre-processing
b. Feature Extraction
c. Dimension Reduction
d. Recognition with Euclidean distance
e. Attendance Marking.

A. Image Capture and Pre-processing :

The Android Smartphone camera is used as camera to capture the image here. An application is developed to capture the Image from Smartphone and send to the computer for processing. With the help of router which is used as a transmission medium. The Image is sent from the Smartphone to the System through the Router. There has to be an internet connection of minimum speed of 512 kbps. Also the application has to be in range of the Router. After the image has been received to the system, in pre-processing, the input image is cropped and resized.

Cropping & Resizing: The input image is cropped to get the face image using Viola Jones algorithm [5] as in fig.3.2 Then face image is resized to a uniform size (180x200) after cropping the faces images to train easily as in fig .3.3

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3.2.Input image

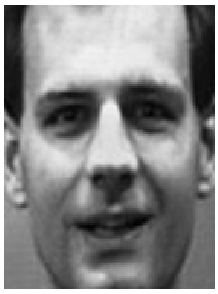

Fig.3.3. Cropped Image

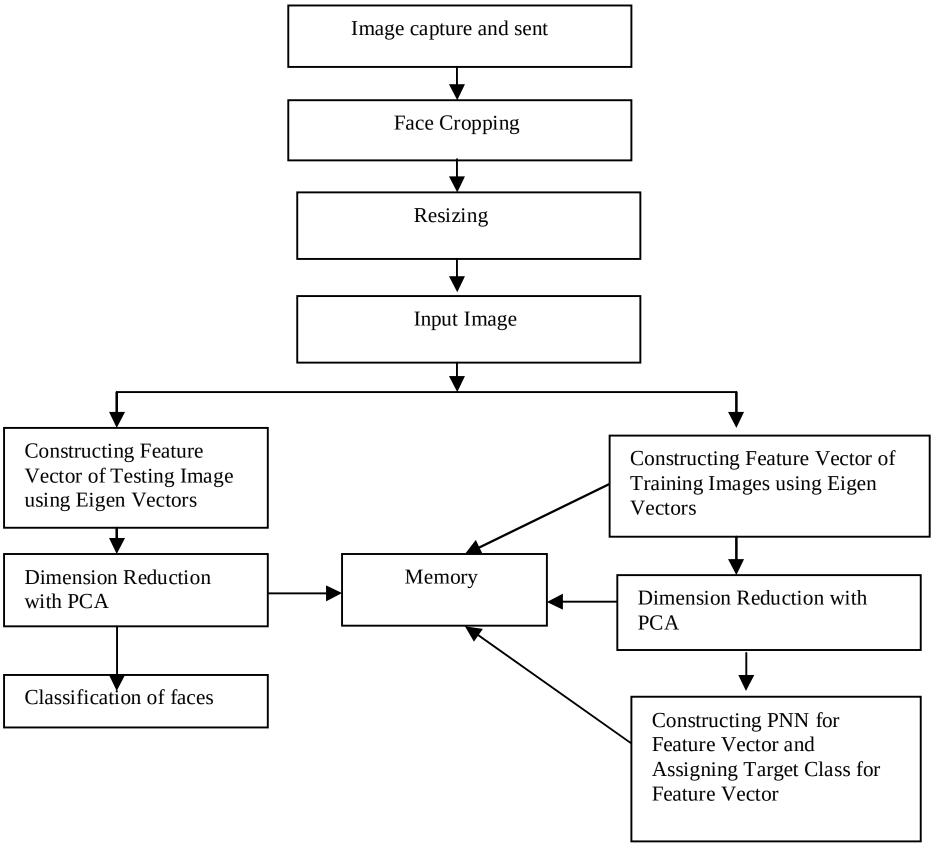

Fig.3.1 Block Diagram of the System

B. Feature Extraction With Eigen faces :

To extract features from the gray scale face image, Eigen Value is applied to the gray scale face image with 8 orientation and 5 scales (size of 40) in the following equation (1)[15][16]

$$p_A(z) = \det(zI - A) = \prod_{i=1}^{k}(z - \lambda_i)^{\alpha_i}, \quad \text{eqn. (1)}$$

Where 'det' is the determinant function of the equation, the 'λ_i'represent all the unique Eigen Values of A and the 'α_i' refers to the corresponding algebraic multiplicities. The function given above '$p_A(z)$' is the *characteristic polynomial* of A in that equation. So the algebraic multiplicity is the multiplicity of the Eigen

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Value as a 0 of the characteristic polynomial. Thus any Eigen Vector can also be a generalized Eigen Vector, the geometric multiplicity should be less than or equal to algebraic multiplicity. These algebraic multiplicities add up to '*n*', of the characteristic polynomial. The equation '$p_A(z)$' = 0 is called the *characteristic equation*, because its roots are exactly the Eigen Values of *A*.
Thus each pixel is then represented by 40 Eigen vector features.

Fig.3.4.Original parts of Eigen face

Fig.3.5 Magnitude parts of Eigen faces

For a 256 × 256 image, the size of transformed image is 256 × 256 × 5 × 8. So the convolution output produce feature vector which has 16380 features for each image.

The Original and magnitude part vectors with eight orientations and five frequencies are given in Fig.3.4, 3.5.

C. *Dimension Reduced with PCA:*

As a consequence of Eigen vector, a high dimensional feature vector is obtained. Therefore, it is compulsory to reduce the dimensionality of the feature vector obtained.

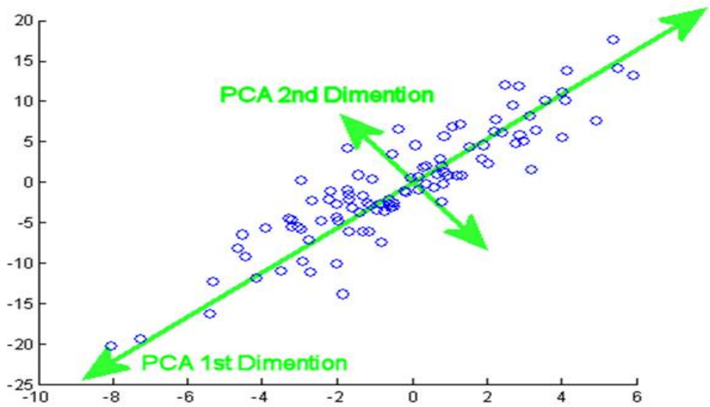

Fig. 3.6 Eigen feature vector

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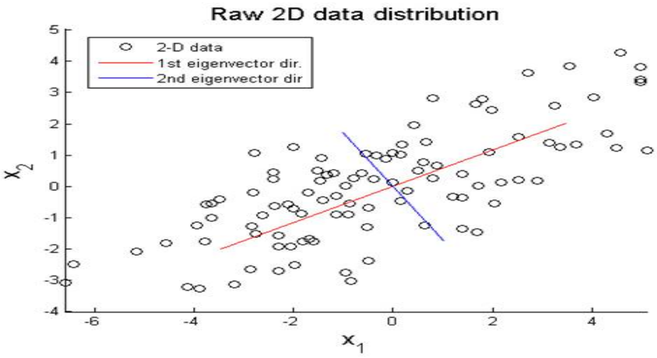

Fig.3.7 Magnitude parts of Eigen feature vector

Principal component analysis as shortened to PCA [4] is an approach used to reduce the dimensionality of a feature space that contains an array of data points and constructs a smaller dimensional linear sub-space that best describes the changes in these data points from their average [13].

In effect of this some principal components can be removed, because they give details only a small amount of the data, whereas the largest amount of information is contained in the other principal components. Dimensionality reduction of PCA is as follows in equation (4):

$$Y = P \times X \quad \text{eqn.(2)}$$

Where Y defines lower dimensional feature vector, P = [P1, P2… Pn] contains 'n' eigenvectors corresponding to leading Eigen Values of the matrix of X. The lower dimensional vector matrix Y captures the most expressive features of the original data matrix X. This work has lower dimensional feature vector has 3200 features for each face image.

D. Recognition With Euclidean Distance:

Probabilistic neural network which is also called as PNN is one of the radial basis network approach suitable for classifying problems that are based on Image Processing. Probabilistic neural network (PNN) was developed by Specht [9]. It features a feed-forward architecture and supervised training algorithm. But still, a back-propagation neural network has to be trained which takes a long time to get trained and know about the relationship between input variables and output variables from the given dataset.

Furthermore, a sufficient dataset must be available to partition the data into a training dataset and a test dataset to avoid over fitting [6].

An alternative method is calculating Euclidean Distance. Without altering the given input layer weights using the generalized delta rule, each trained input pattern can be used as ta connection weights to a new hidden unit. This gives several advantages over back-propagation network. Training is much quicker and usually a single iteration process. Moreover, it allows true incremental learning where new training data can be added without needing the process of retraining the entire network. It also possesses some useful characteristics as the back-propagation algorithm such as generalization ability. The Euclidean distance

Between points p, q is

$$\mathrm{d}(\mathbf{p},\mathbf{q}) = \mathrm{d}(\mathbf{q},\mathbf{p}) = \sqrt{(q_1-p_1)^2 + (q_2-p_2)^2 + \cdots + (q_n-p_n)^2}$$

$$= \sqrt{\sum_{i=1}^{n}(q_i-p_i)^2}. \quad \text{eqn.(3)}$$

This process involves calculating the Euclidean distance among various points in face and generating a value for each image in the training dataset. Now a test dataset is created by including the images from the train dataset and also images not from them. When allowed to execute the images from train dataset allowed going through the process of calculating the Euclidean distance. A set of 1-D values for the images are produced and stored. Now the images from the test dataset is taken and compared with the train dataset. The Euclidean value closest to the images in Train dataset is matched with the Test Dataset.

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The results reflect that the predictive ability of the calculating the Euclidean distance is efficient than the others.

E. Attendance Marking

After the image is matched, the id of that person has to be marked the attendance. An Excel spreadsheet is prepared with the names of the person in the class. Now this Spreadsheet has to be connected with the program. When the id is matched, the attendance for that person is marked. This Spreadsheet can be used for any future reference if needed.

IV. RESULTS AND DISCUSSION

Data required for experimentation is collected for testing. The Database contains 320 images of 10 facial expressions posed by 32 different male and female models.

Figure.4.1. Sample Facial expressions from data base

It was observed from the work that the images in the range 134–154 (all belong to the expresser UY) and 199–219 (all belong to expresser NA) were difficult to interpret and highly erratic. Hence expressers NA and UY were considered to be outliers. Thus it is found that the problem was present in the expressers expressing the expressions. So experiments were carried out by removing these persons images from the data set.

Thus by not including those images belong to that two unreliable expressers from the data set, generalized recognition rate of 86.2% for test data and 100% for training data is achieved as shown in Table 1.

Table 1 Confusion Matrix for 6-Classes of Facial Expressions

Principal Component	Eigenvalue	Variance (%)	Cum. Variance (%)	Principal Component	Eigenvalue	Variance (%)	Cum. Variance (%)
1	0.010167	31.972	31.972	10	0.000226	0.711	98.997
2	0.008739	27.483	59.455	11	0.000127	0.401	99.398
3	0.005788	18.201	77.655	12	0.000110	0.345	99.742
4	0.002277	7.159	84.815	13	0.000056	0.177	99.919
5	0.001595	5.014	89.829	14	0.000019	0.059	99.978
6	0.001099	3.455	93.284	15	0.000005	0.016	99.994
7	0.000677	2.130	95.414	16	0.000002	0.005	99.999
8	0.000522	1.641	97.055	17	0.000000	0.001	100.000
9	0.000392	1.231	98.286	18	0.000000	0.000	100.000

Table 2 Comparison of different faces

Measurement / Experiment	The number of faces	The number of detected faces	Detection rate	Error rate	Miss rate
Ordinary image sequence	50	48	96.00%	2.00%	2.00%
	100	94	94.00%	2.00%	4.00%
	150	142	94.67%	0.67%	4.67%
	200	187	93.50%	1.00%	5.50%
Jumble image sequence	50	45	90.00%	6.00%	4.00%
	100	91	91.00%	5.00%	4.00%
	150	134	89.33%	6.00%	4.67%
	200	181	90.50%	6.50%	3.00%

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In Table 2 the result of the study is compared with earlier work in which the experimental settings are comparable. It shows that the given technique presented is equally good in discriminating faces.

V. CONCLUSION

This study effectively uses facial recognition and PCA as the feature extraction tool. The result is successful enough to discover real-life applications of facial expression recognition in fields like surveillance, Security purposes and human computer Interaction etc.

The present approach can be extended with different classifiers like Adaboost, SVM. It is also possible to include different techniques to avoid fake entry in the attendance system.

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