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RESEARCH ARTICLE

A Face Recognition Approach for Universal Identification (FL-UID)

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Abstract—FL-UID is a face recognition technology that enhances the identification and verification of citizens being part in the election procedure. Facial recognition is a type of biometric software application that can recognize a specific person using his digital image by analyzing and comparing some patterns. These systems are commonly used for security and authentication purposes. This application is implemented with three techniques PCA (Principal Component Analysis) which does the dimensionality reduction, LDA (Linear Discriminant Analysis) which does the feature extraction and Neural Network which does the actual matching. Mainly there are two sections i.e., identifying a voter and recognizing him to cast vote. In the proposed election procedure the user comes to vote and his image is captured, captured image is transformed into a matrix and is given for PCA, LDA and neural networks. The final output is an image, the recognized and identified one. If recognized, voting machine is enabled, otherwise disabled. This technology can be implemented with MATLAB and can be integrated with the election system. Simulation results demonstrated that the proposed system can improve authentication and also the problem of bogus vote can be entirely eliminated.

Keywords: Face recognition; Principal Component Analysis (PCA); Linear Discriminant Analysis (LDA; Neural Network; Back Propagation.

I. INTRODUCTION

Face Recognition System has the underlying principle of pattern recognition. The electoral system has the weaknesses in validating the voters and thereby we face the problems of bogus voting. The existing procedure is manual where a voter is been identified and verified merely by his voters ID card. Any manipulation in the card can affect the security, thereby; a voter can manipulate his identity and generate proxy votes, favoring an electoral candidate. Manual verification also weakens the authentication of the entire

system, since the administrator is the person who controls the whole system. Manually the voter is called and his identity is verified by the administrator. If the personal authorized to do this is corrupt, he can favor a particular candidate and help the voters to cast multiple votes.

Many biometric researches are being carried out for enhancement of the system. Facial recognition, iris, retina, hand geometry, signature dynamics and speaker verification are the popular biometrics being used in many security systems [1]. The proposed technique (FL-UID) uses facial recognition, the most natural means of biometric identification. In this approach the image of the face is captured and used to identify the person.

In this paper, we put forward an efficient approach to integrate the facial recognition technique with the electronic voting system. Facial recognition can be implemented using different algorithms such asPCA (Principal Component Analysis), LDA (Linear Discriminant Analysis).PCA and LDA are two powerful tools used for dimensionality reduction and feature extraction in most of pattern recognition applications. Using the PCA or LDA alone will not be an accurate face recognition algorithm, but experiment results have shown their combination makes it efficient.Finally Neural Network is used for pattern matching to identify and validate the image.[2]

The rest of this paper is organized as, section 2 is presentation of the proposed approach in detail, Section 3 contains Experimental results and Section 4 is Conclusion.

II. PROPOSED VOTING SYSTEM

In this section, the proposed system with its implementation is presented.

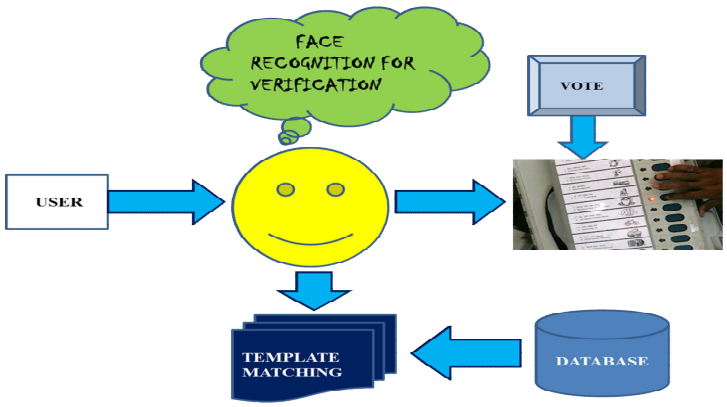

Fig.1 Proposed voting system

First when a person is coming in, his/her image is capture by the camera provided. He/she should follow the instructions when standing before the camera prior to the capturing of the image. After the image is captured it is given for further processing and identification. Noise reduction is the first process where any disturbances or error in the image are reduced. Principal Component Analysis is applied to this image for dimensionality reduction which is done to improve the performance [3].Then Liner Discriminant Analysis is applied where the most discriminating features of the person are extracted and given as the input for neural network. Neural network performs the exact matching of the faces. This will comprise the templates which are used for matching [4]. Back propagation algorithm is used in the neural networks [5] .Finally when a match is detected the voting machine is enabled and the user who is the voter is allowed to cast his vote. Else if match is not found an alarm is activated and the voter is not able to cast the

vote. And also if it is found that the same voter is trying to cast his vote multiple times then also the system will be disabled and the alarm will be activated.

A. Facial recognizer

The recognition system uses the algorithms PCA and LDA for dimensionality reduction and feature extraction. The features are then passed to the Neural Network for pattern matching [6]. Basically the software part consists of algorithms along with Neural Network implementations. As on the hardware part a dedicated server, high resolution camera and a high performance computer is required. The image is first captured by the camera, processed with the algorithms and stored in the database. During the election procedure the trained Neural Network does the pattern matching on the extracted features and identifies the person.

1) PCA (Principal Component Analysis) And LDA (Linear Discriminant Analysis): PCA and LDA are two powerful tools used for dimensionality reduction and feature extraction in most of pattern recognition applications [1]. Feature selection (or variable selection) is a fundamental step in computational intelligence fields like computer vision, bioinformatics and natural language processing. Many problems in all of these domains deal with very high-dimensional data. The goal of PCA is to reduce the dimensionality of the data while retaining as much as possible of the variation present in the original dataset. PCA is not always an optimal dimensionality-reduction procedure for classification purposes. LDA perform dimensionality reduction while preserving as much of the class discriminatory information as possible.

PCA is first applied to the image set captured to reduce its dimensionality. LDA is then applied to further reduce the dimensionality and for extracting the features [7]. LDA is preferred over PCA; this is mainly because LDA deals directly with discrimination between classes while PCA does not pay attention to the underlying class structure when the training set is small. PCA can outperform LDA and when the number of samples is large and representative for each class, LDA outperforms PCA. So it is better to use both PCA and LDA together to get the required result and there is no problem whether the sample set is small or large [8].

PCA (Principal Component Analysis): A 2-D facial image can be represented as 1-D vector by concatenating each row (or column) into a long thin vector.

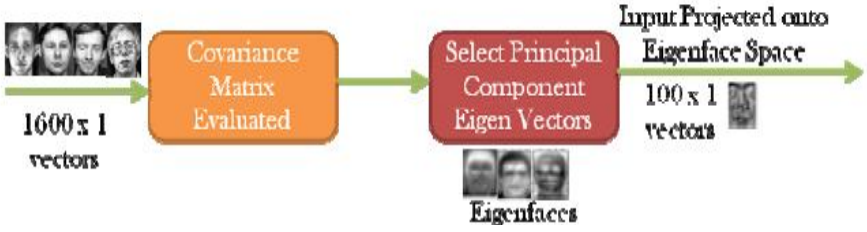

Fig.2 Flowchart for Dimensionality Reduction step

The training database consists of M images which is same size. The images are normalized by converting each image matrix to equivalent image vector Γ_i. The training set matrix Γ_i is the set of image vectors with

$$\text{Training set } \Gamma = [\Gamma_1\ \Gamma_2 \ldots\ \Gamma_M] \qquad \textbf{(1)}$$

The mean face (Ψ) is the arithmetic average vector as given by:

$$\Psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma_n \qquad \textbf{(2)}$$

The images are mean centered by subtracting the mean image from each image vector as in equation (3). And let Φ_i be defined as mean centered image

$$\Phi_i = \Gamma_i - \Psi \qquad \textbf{(3)}$$

Consider a difference matrix A= [Φ_1, Φ_2, ... Φ_M] which keeps only the distinguishing features for face images and removes the common features. Then eigenfaces are calculated by find the Covariance matrix C of the training image vectors by:

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi_n.\Phi_n^T = A.A^T \qquad \textbf{(4)}$$

LDA(Linear Discriminant Analysis): The LDA algorithm will further help in the dimensionality reduction, the main function of this is to extract features and divide the images into different classes so that it is easier for the NN to perform the recognition process [9]. LDA searches directions for maximum discrimination of classes in addition to dimensionality reduction. To achieve this goal, within-class and between-class matrices are defined. A within-class scatter matrix is the scatter of the samples around their respective class means μ_i is given in equation (5):

$$S_w = \sum_{i=1}^{C}\sum_{j=1}^{M_i}(y_j - \mu_i)(y_j - \mu_i)^T \qquad \textbf{(5)}$$

where $\boldsymbol{\Sigma}_i$ is the covariance matrix of *i*-th class. The between-class scatter matrix is the scatter of class means μ_i around the mixture mean μ , and is given by:

$$S_b = \sum_{i=1}^{C}(\mu_i - \mu)(\mu_i - \mu)^T \qquad \textbf{(6)}$$

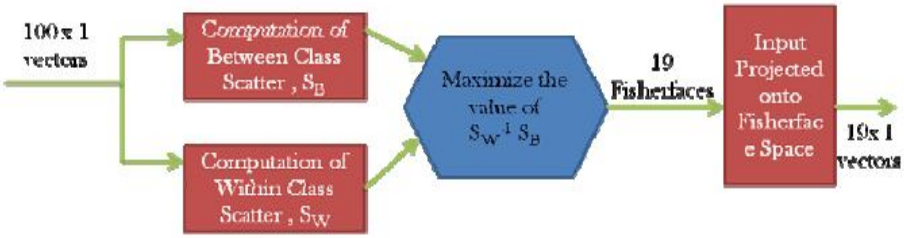

Fig. 3. Flowchart for Feature Extraction using LDA

Figure 3 shows the flowchart of Feature Extraction step. Outputs of dimension reduction part are 100×1 vectors. Features are extracted from these vectors. 19 principal components which are selected from among the eigen vectors form the features. The preprocessed face images projected on to the eigen space, is now, projected onto the fisher space and thus results in 140, 19×1 vectors which are used as input of neural network.

Fig 4 Images obtained after dimensionality reduction and feature extraction

Figure 4 shows the face images after the PCA and LDA. The dimensionality of the original face is reduced and we are extracting only the features of the face images, so the result of PCA and LDA is a set of blurred images as in figure 4.

B. Neural Network

Neural Network is a pattern classifier .The Back-Propagation is the best known and widely used learning algorithm in training multilayer perceptrons (MLP). The MLP refer to the network consisting of a set of sensory units (source nodes) that constitute the input layer, one or more hidden layers of computation nodes, and an output layer of computation nodes [8]. The input signal propagates through the network in a forward direction, from left to right and on a layer-by-layer basis.

Back propagation is a multi-layer feed forward, supervised learning network based on gradient descent learning rule. This BPNN provides a computationally efficient method for changing the weights in feed forward network, with differentiable activation of functional units to learn a training set of input-output data [10]. The aim is to train the network to achieve a balance between the ability to respond correctly to the input patterns that are used for training and the ability to provide good response to the input that are similar.

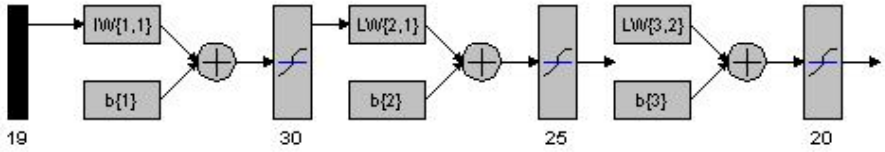

Fig 5. Architecture of BPNN implemented

Figure 5 shows the architecture of BPNN used for classification. The network implemented consists of an input layer with 19 neurons, two hidden layers first with 30 and second with 25 neurons respectively and an output layer with 10 neurons. Three layers MLP neural network will train using training face images and at its output layer, it produces a 10×1 vector that each elements of that vector is a number between zero and one representing similarity of input face images to each of ten classes. Training face image enter the neural network and according to their class, a back propagation error, spread on the network and correct the weights toward the right values. The input face image will classified to the class which has the greatest similarity to it.

III.EXPERIMENTAL RESULTS AND DISCUSSIONS

We applied the face recognition method on a face dataset created by our own for separation of ten classes. For all experiments, we used Matlab code running on a Windows 7 laptop with Intel Core 2 Duo processor and 2GB RAM. Our selected database contains grayscale images of 10 subjects in jpg format. In these experiments, we considered 10 images per each subject (total 100 images) containing different illumination and different poses, which 5 images of each used for training and remaining 5 images used for testing the method.

A. Performance

In this section, to demonstrate the performance, the proposed system was compared with the manual verification technique in terms of speed. The results are shown in the table below.

TABLE I
Comparison of FL-UID and Manual Method

System	**Speed**
FL-UID	12 seconds
Manual	30 seconds

To start the analysis both manual and FL-UID were set up. Then persons were asked to start the voting procedure. During the process the speed of completion was monitored and time was calculated. From the table I it is clear that the speed of the identification process is good compared to the manual system.

The training set consisted of ten images and was noticed that if we increase the number of training sets the accuracy increases, thus FL-UID is highly accurate. The security was calculated at both manual and FL-UID, manual was less secure as multiple votes could be made by the same person which was not possible in FL-UID.

B. Recognition Rate

Five images were selected from each person‘s 10 images and stored as known faces in the database. The remaining images are used for testing. After testing the recognition rate is calculated as follows.

Recognition Rate = 100 * (Number of face images correctly recognized / Total number of face images tested).

Recognition rate was observed by varying number of training images and testing images.

TABLE III
Result of the Experiment Conducted

No: of Training Images Used for Each Subject	**No: of Testing Images Used for Each Subject**	**Recognition Rate**
7	3	98%
6	4	95.5%
5	5	94%

Table II shows the result of the test conducted on the face database. Three cases (number of training samples taken as 7, 6 & 5) are considered here. The recognition rate for system using BPNN as classifier is found to be very high.

It can be noted from Figure 6 that the input test face is correctly matched to the person and his details are displayed. Then he is allowed to cast the vote. The only limitation is that whenever a new person comes his face is matched with an already existing person.

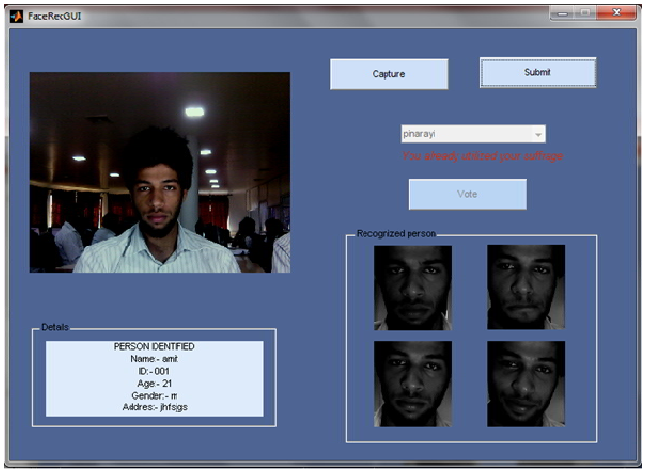

Fig. 6: FL-UID screen after recognition and identification

IV.CONCLUSION

In this paper, we proposed biometric integration to the existing voting system.The existing one authenticates voters just with their electoral ID card. In this system, image of a citizen is taken prior for creating a database and on the voting day also when he or she comes to vote his or her image is captured and given to the system. Using the algorithms PCA, LDA and Neural Network exact matching and identification is done. Thus the voting is enabled or disabled based on the system output. The experimental results demonstrated that the speed, accuracy, and security of the system were better.

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