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A HYBRID ALGORITHM FOR FACE RECOGNITION USING PCA, LDA AND ANN

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ABSTRACT

Face recognition is an evolving technique in the field of digital device security. The two procedures Principal Component Analysis and Linear Discriminant Analysis (LDA) are standard methodologies commonly used for feature extraction and dimension reduction techniques extensively used in the recognition of face system. This paper discourse, PCA trailed through a feed forward neural network (FFNN) called PCA-neural network and LDA trailed through feed forward neural network as LDA-neural network are considered for development of hybrid face recognition algorithm. In the current research work, a hybrid model of face recognition is presented with the integration of PCA, LDA, and FFNN. The proposed system experimental results indicate better performance compared to the state of the art literature methods.

Key words: Face Recognition, PCA, LDA, FFNN

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1. INTRODUCTION

Facial recognition is a form of biometric technique that can recognize an exact distinct image in the database by evaluating and relating patterns. So many users of the computer extremely use a very less and easily predicted poor credentials (such as the password), this result gives you to the predictors can estimate other user's credentials and access all the information in an illegal way. The term biometrics can resolve all type of credential complications by demanding an extra credential somewhat connected with the person's private body. The primary intention of this application is to prevent the frauds from accessing secured resources. This Biometrics offers the reliable solution through some technologies. As part of biometrics, the face recognition plays a very important role. The capable of recognizing or confirming a person from the digital image or from the video source the face recognition system place a very important role in the digital world. This paper discourse, the states of the art face recognition to increase the growth of the system by using a neural network.

Mathew Turk and Pentland [1] proposed an almost real-time computer application that can locate and track an information and it recognizes the person by characteristics of the face for small two-dimensional (2-D) dataset rather than requiring the three-dimensional geometry. They used significant features called eigenfaces because they have corresponding eigenvectors and some particular advantage of this method was to an ability to learn and later recognizes the new faces in an unsupervised manner by using neural networks.

Kamran Etemad and Rama Chellappa [2] projected an automatic face recognition (AFR) by using linear discriminant analysis (LDA) it provides a more reliable recognition result with high classification accuracy with the usage of very less dimensional estimate vectors compared to PCA based eigenfaces. This method used an ORL dataset for their experiment results and this method is widely used in all-purpose and it is appropriate to several other face recognition task also.

Built on the principal component analysis (PCA) and Linear discriminant method a new face recognition technique was introduced by Hossein Sahoolizadeh, Youness Aliyari Ghassabeh using a neural network. They experimented with using benchmark database called Yale face dataset that invented method gives less misclassification compare to the previously proposed methods. The combination of PCA, LDA and Neural networks algorithm gives very strong recognition rate with an effective way of face recognition. Several security systems and other applications use this proposed method.

By merging two methods called transformation technique is also known as PCA and linear discriminant analysis the hybrid face recognition system was proposed by W. Zhao R. Chellappa A. Krishnaswamy [4]. The proposed idea is to increase the generality proficiency of LDA method only when a small set of images exists in a class. In this experimentation to determine a significant development in both PCA and LDA are merged together and tested on FERET dataset.

2. PROPOSED METHOD

The first step is to give the images data for calculate Eigen faces and fisher faces of corresponding principal component analysis (PCA) and linear discriminant analysis (LDA) and to achieve the feature vectors from the given dataset and obtained output is passed to the artificial neural network classifier to perform better classification of images. Figure 1 presents the block diagram of the method proposed.

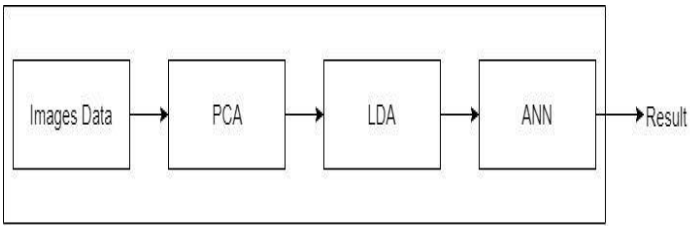

Figure 1 Block Diagram of Method Proposed

Principal Component Analysis (PCA)

It is one of the standard unsupervised technique for reducing the dimension of the dataset without any loss of important information in the original dataset and possibly to feature selection. PCA based algorithm has been the base of the several research projects in computer vision. PCA is a typical de correlation repetition in the present research, one originates dimension reduction for classification problems based on the orthogonal projection basis.

One common method for attribute selection and transformation technique is PCA [5], [6]. PCA is one of the benchmark decorrelation exercise in contemporary research, it originates a right-angle projection source which points to transformation, and certainly to a feature selection method. Let us consider an equation $X \in IR^N$ be a random vector demonstrating an image, Where *N* is the dimensionality of the image. By combining the rows attributes and column attributes of the image the vector is designed [7]. Let's consider *X* is covariance matrix is stated as follows*:*

$$\Sigma_X = E\left\{\left[X - E(X)\right]\left[X - E\left(X\right)\right]^t\right\}, \tag{1}$$

Where *E (.)* is the expectation operator, *t* denotes the transpose operation, and $\Sigma_X \in IR^{N\times N}$.

The PCA of a random vector *X* factorizes the covariance matrix $\sum_X$ into the following form.

$$\sum_x = \Phi\Lambda\Phi^t \quad with \quad \Phi = [\phi_1\phi_2....\phi_N], \Lambda = diag\{\lambda_1, \lambda_2, ..., \lambda_N\}, \tag{2}$$

Where

$\Phi \in IR^{N\times N}$ = right angle (orthogonal) eigenvector matrix

$\Lambda \in IR^{N\times N}$ = diagonal eigenvalue matrix with diagonal elements in the order of decreasing way $(\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_N)$.

The significant assets of principal component analysis (PCA) are decorrelation, i.e., the modules of the transformation, $X'=\Phi^tX$, are decorrelated since the covariance matrix of X' is diagonal, $\sum_{X'}=\Lambda$, the variances of the parallel components are represented by the diagonal matrix. Optimal signal reconstruction in the sense of minimum Mean Square Error (MSE) is another property of PCA. When only a subset of principal components where $P= [Ø_1, Ø_2 \ldots Ø_m]$, $m < N$ and $P \in IR^{N \times m}$ are used to denote the original signal. Following this property, an instantaneous application of principal component analysis is the transformation technique:

$$Y = P^tX. \tag{3}$$

If the training dataset is very less PCA can overtake LDA and Aleix M. Martinez and Avinash C. Kak [15] showed that it is very less sensitive to the dissimilar training dataset. The main limitation of transformation technique (PCA) does not differentiate the dissimilar roles of deviation between the classes and within the class and it takes them to the same extent and it will not perform well for large dataset. This always processed to less recognition rate.

Linear Discriminant Analysis (LDA)

The linear discriminant analysis is called as fisher linear discriminant analysis and it discriminates the classes. The supervised technique extensively used for dimension reduction method as well as a classifier in the face recognition system to convert or bring down to the low dimensional space from the high dimensional space based on the linear projection of the LDA. Compare to the classification it is extremely used in feature extraction. The LDA can perform dimension reduction within-class scatter matrix and between the class scatter matrix.

The LDA [8] define two measures for all the samples in the classes i.e. scatter within-class matrix and scatter between class matrix. That is represented by the equation i.e.

1. within the class scatter matrix

$$S_w = \sum_{j=1}^{c} \sum_{i=1}^{N_j} \left(x_{i=1}^{j} - \mu_j\right) \left(x_{i=1}^{j} - \mu_j\right)^T \quad (4)$$

Where c represents the total number of classes or objects, x (i) ^j is i Th model of class j, μj is the average of class j, and Nj the number of models in class j.

2. scatter matrix between the class

$$S_b = \sum_{j=1}^{c} \left(\mu_j - \mu\right) \left(\mu_j - \mu\right)^T \quad (5)$$

Where μ signifies the average or mean of all the classes. The estimated model $\frac{det\ |Sb|}{det\ |Sw|}$ of the fisher linear discriminant analysis is tried to maximize the ration of the determinant factor.

In the experiment result, we showed that first, we tested on the small dataset by using original LDA [9]. But the result was not better because the database is very small and LDA performance enhanced result on the large dataset. So that LDA gives better recognition rate when the database is having more number of images compare to the PCA.

Neural Network – Classification Stage

The neural network is supervised learning algorithm widely used in classification purpose to train and implement a multifaceted or difficult functions in numerous areas of digital image processing. The neural network classifier was equated with some other standard method under some supreme conditions [16]. The neural network is very robust and complex and it gives the better performance result rather than standard statistical classifiers.

Some of the other techniques were equated with Multi-layer neural networks (MLNN) and Radial basis function (RBF) networks [10]. The MLNN achieves the related function with the representing of RBF networks whereas with the different structure and function of the RBF it was trained in a supervised manner. Sepide Fatahi, Ehsan Zadkhosh and Abdollah Chalechale [11] proposed a fisherfaces for face recognition system and multilayered perceptron (MLP) was used for 10 person images 8 images for each totally 80 images from ORL database.

Feedforward Neural Networks (FFNN)

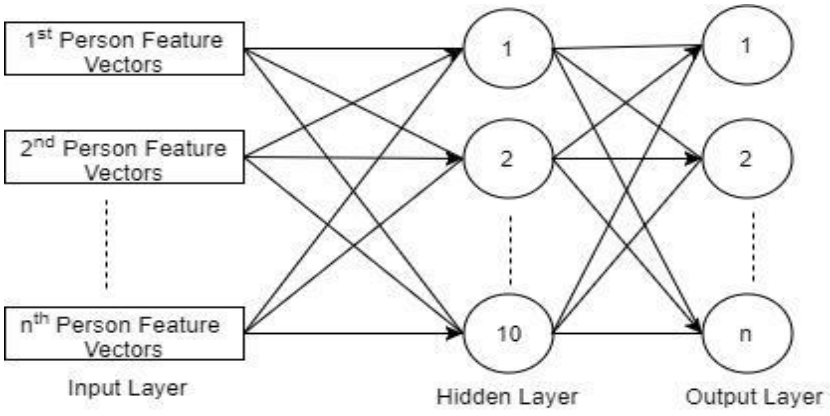

Figure 2 Structural design of Neural Networks

The 3-layer feedforward neural network [12] contains input layer for carrying inputs and a middle layer called hidden layer it will perform some calculation and output layer for showing the final result of the classifier. The data or information it goes only in one direction because the connection between the same or previous layer neurons is not possible. The input layer takes inputs from the PCA or LDA and transfers to the hidden layer and the result of hidden layer are passed as an input for the next level. Figure 2 presents the structural design of the Feedforward neural networks used for the classification.

3. EXPERIMENTS AND RESULTS

Training and Testing of Neural Networks

PCA-NN and LDA-NN are the two neural network classifier are used for classification in the experiment and for training and testing the benchmark dataset is used. The FERET [13] dataset contains images of all frontal faces with variant poses and for performing training in the neural network from each class we considered n-poses and experimented with equivalent class images by taking a n/2 pose from the dataset. By using PCA eigenfaces and prominent principal components are considered for training the neural network [14]. Figure 3 presents the sematic diagram of the PCA based neural network (PCA-NN) training level.

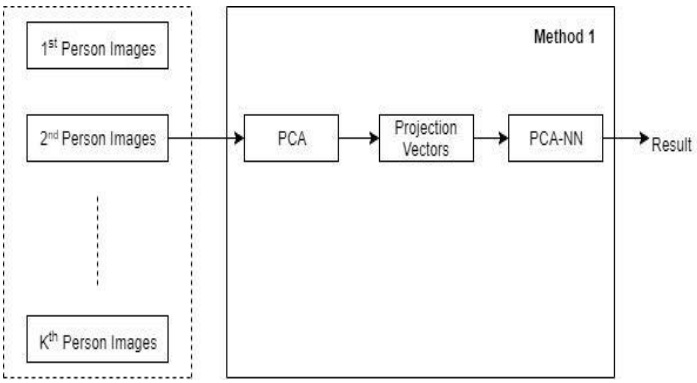

Figure 3 Training level of PCA-NN

Similarly, by using a supervised method called linear discriminant analysis is used for calculating fisherfaces for training data after calculating that, estimate vectors are obtained. Figure 4 presents the LDA based neural network (LDA-NN) training level. For recognizing the new images from the test data the equivalent image values are passed to the fisherfaces and estimate vectors are obtained this can be served to corresponding neural network classifier to calculate the better result.

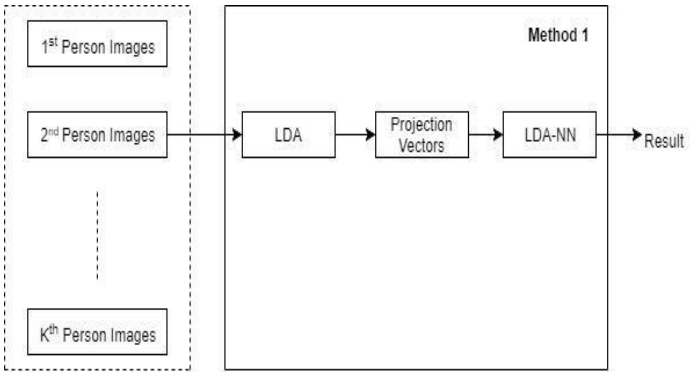

Figure 4 Training level of LDA-NN

We conducted three experiments on PCA-NN and LDA-NN to improve the recognition performance. Based on the How many images are in the training data. The first experiment our objective is to know, what is the number of images that gives you the best recognition result using neural network classifier.

Phase I

So we experiment training dataset has 20 images of 10 person having two images for each person and test data has 10 images and one image for each person. Therefore, obtained experimental result shows that PCA has best recognition result over LDA. It indicates that if there is a small dataset PCA perform better recognition compare to LDA. LDA will not perform better recognition for small dataset so we conducted the second experiment with a large number of training images to obtain best recognition rate.

Figure 5 Training Sample Images

Phase II

In this testing, the number of training and test images for each class are increased compared to first experiment result. Therefore, here we tested 40 images in the training set of 20 persons contain two images for each and 20 test set images one person for each. Then images in the training dataset are greater than before by double of the first experiment result.

Basically, if the number of epochs is more of training there is less error rate and vice versa. But might tried to increasing in the validation dataset there are overfitting chances in the network of the training data. If there are six sequential growths in the validation error the training will stop automatically because of the default setup in the neural network GUI and obtained experimentally is taken from less validation error with the best number of epochs. The figure 6 shows that there some overfitting in the PCA based neural network but it performs better result on LDA based neural network it shown in figure 7.

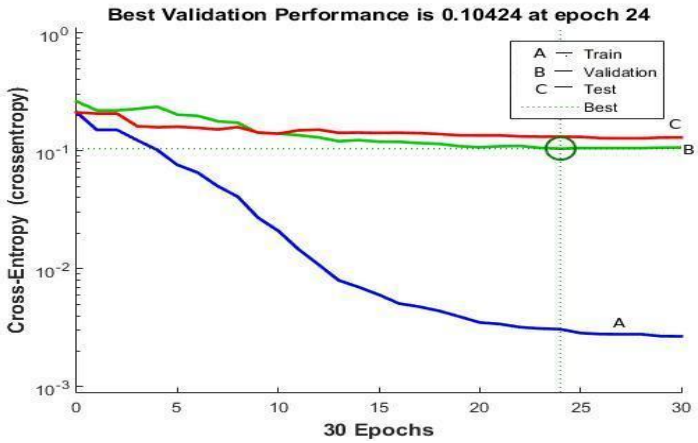

Figure 6 PCA performance graph

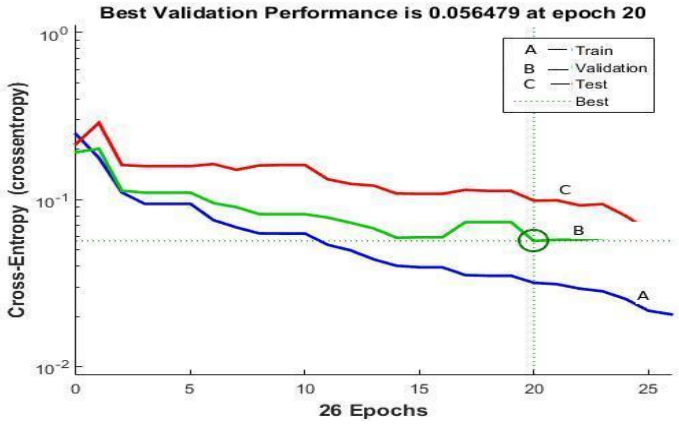

Figure 7 LDA performance graph

Phase III

This experiment shows you that if the data set containing 60 images in the training data set of 30 persons contain two images for each and 30 images in the test data set contain one person for each. It shows good recognition rate in LDA compare to PCA because training dataset has more number of images compare to the previous experimental result that is presented in figure 8 and figure 9.

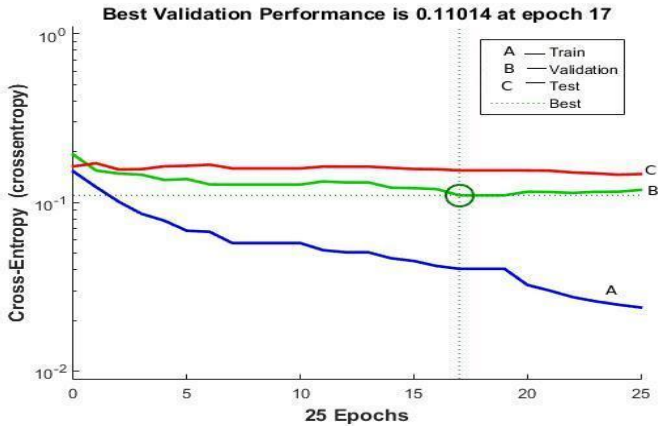

Figure 8 PCA performance graph

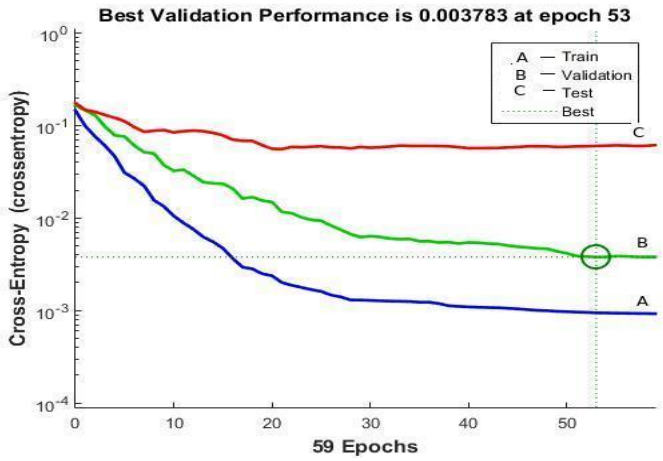

Figure 9 LDA performance graph

4. CONCLUSIONS

This article shows that the PCA-NN and LDA-NN with feedforward neural networks classifier continuously improve the face recognition rate compared to the formal literature approaches. Correspondingly the LDA-NN shows that it performs better recognition rate only for large dataset as well as PCA-NN shows that it performs better result only for the small dataset. On the contrary by comparing LDA-NN with PCA-NN the high recognition rate performed by LDA-NN. The three different set of experimental results shows the neural network established PCA-NN and LDA-NN Performance.

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