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Face Recognition Using Principal Component Analysis Based Feature Space By Incorporating With Probabilistic Neural Network

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ABSTRACT
Face recognition is one of the highly focused area for the researchers due to its persistent and reliable features. In this paper, we propose a reliable and computational efficient model for face recognition. Principal component analysis (*PCA*) is used to collect statistical based features from sub region of the face images. Different nature classification learners such as Probabilistic Neural Networks (PNN), support Vector Machine (SVM) and Random forest (RF) are utilized to measure the performance of the proposed system. 10-folds cross validation test is employed to assess the prediction rate. After empirical investigation, it is observed that *PNN* has considerably enhanced the success rates of the proposed model. Our proposed model might be useful and helpful in security related applications.

Keywords:- PCA, PNN, Preprocessing, RF, SVM.

I. INTRODUCTION

Face recognition system identify psychological and demographic characteristics such as age, height and gender are enormously used in the area of pattern recognition and machine learning (Jain et al., 1999). Automatic facial recognition plays a vital role in surveillance development, security issues, and many other social responsibilities [2]. Various number of approaches has been utilized by the researchers to develop a face recognition system such as Local binary pattern (Huang et al., 2011); (Shan et al., 2009), discrete wavelet transform (Wadkar and Wankhade, 2012)], gabor filters [6], independent component analysis [7], genetic algorithm [8] and linear discriminant Analysis [9] are widely been used to extract unique and reliable features. Lin et al., detected the face components through probabilistic decision based neural network (PDBNN) approach. The proposed techniques are tested on FERET and Oral face Databases [10]. Similarly, Meng et al., used principal component analysis to extract features. Fisher's linear discriminant is utilized to minimize extracted feature set. Furthermore, *RBF* neural classifier is In this work, we proposed a robust and intelligent computational model for face recognition. Features utilized to calculate the recognition rate [11]. Jesorsky et al., localized the face features using edge-based and hausdorff distance method [12]. Likely, Anila et al., implemented a facial detection system by divided the preprocessed images are into blocks to extract features. Back propagation neural network is applied to classify the blocks of the image [13] [53-55]. Kim et al., proposed face recognition model, local directional pattern and two dimensional principal component analysis (2D-PCA) are utilized to obtain features. The proposed approach was computationally efficient and achieved robust against illumination variation [14]. Similarly, Yi et al., used a novel approach to recognize faces with different poses. 3D deformable model is developed to calculate pose information. Features are extracted using Gabor filters and in order to remove redundant features PCA is applied [15].Furthermore, Cao et al., proposed a new learning based descriptor model and pose adaptive matching for face recognition. The proposed method is tested using LFW face dataset [16].

are extracted using PCA based feature representation scheme. Various classification

algorithms are utilized to evaluate the performance of proposed model.

The rest of the paper is organized as follows: Materials and Methods are represented in Section 2. Section 3 represents Results and discussion and finally conclusions are drawn in the last Section.

II. MATERIALS AND METHODS

A. *Datasets Description:*

In order to develop an efficient and robust recognition system a benchmark dataset is always essential to train the model. In this work, we have used two benchmark face datasets. SUMS dataset contains 400 images having equal number of instances of the both classes male and female [17]. All the images are stored in JPEG format. On the other hand, Dataset 2 contains 100 images of 438*539 pixel .The dataset 2 is equally divide into both male and female classes.

Figure 1. Samples face from Dataset 1

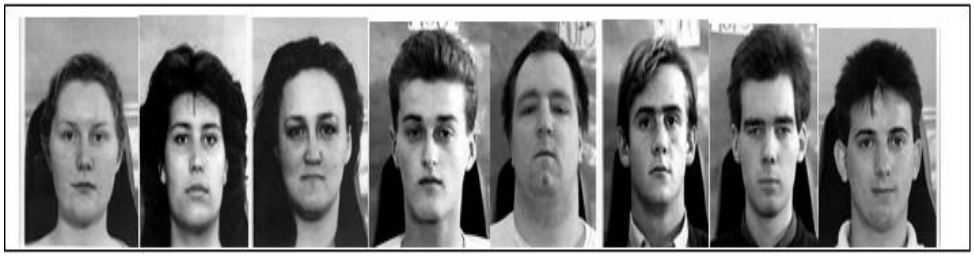

Figure 2. Samples face from Dataset 2

B. *Principle Component Analysis (PCA):*

In this work, we have utilized Principle Component Analysis *(PCA)* to extract features from face images in the form of Eigen vector and Eigen value [18].

1) Eigen Vector and Eigen values:

Using PCA, we have extracted the features of Eigen vector and Eigen values of each image. Let us suppose, initially we have the set of face images $\left[A_1 + A_2 \ldots\ldots A_n\right]$.

First, we have calculated the mean of the whole face distribution

$$A = \left(A_1 + A_2 \ldots\ldots A_n\right) / n \quad (1)$$

Then we subtracted the mean from each image vector

$$A_i' = A_i - A$$
$$i = 1, 2, \ldots., n \quad (2)$$

Eigenvectors [X_1, X_2… X_n] are calculated from the new image vector [A_1', A_2',…., A_n'].

The calculated Eigen vectors are orthonormal to each other. Each of the Eigen vector has an Eigen Value. High Eigen value gives more information than those of low Eigen value. Then, we calculated the covariance matrix of the calculated Eigen value and Eigen vector. After that the Eigen faces are extracted from the covariance matrix. Each face is then projected onto the eigenface space and represented by a linear combination of the eigenfaces. In this paper, we have extracted 165 features using PCA.

C. *Random Forest (RF)*

Random forest is a prominent classification learner that was introduced by Breiman [19]. *RF* is rule based classifier that construct decision tree and split the features randomly in subgroups iteratively and each of the tree have equal number of chance to be sampled [20]. At each node the most discriminative variable with a cut off value is found and divide database into two parts [21; 30].*RF* is

mostly suitable for executing lager datasets. Random forest is less sensitive to the used parameter as comparing other classification learners [22].

D. Support Vector Machine (SVM)

SVM is extensively used classification algorithm that classifies objects based on statistical theory. SVM is computationally efficient as compared to other classification algorithms [23]. SVM is the fast hypothesis learner that can efficiently classify linear as well as non-linear problems [24]. SVM is a supervised learning algorithm that draws a parallel line to hyperplane that has largest margin and minimum classification error to separate data of different classes [18; 25], [56-66]. SVM uses different kernels such as linear, polynomial and radial basis kernel function [26] [29-40] [67-74].

E. Probabilistic Neural Network (PNN)

PNN is a feed forward neural network based classification algorithm that was developed by D.F. Specht [27]. PNN is not only reflects neural network paradigm, but also adapt statistical Bayesian decision rule [28] [41-52]. PNN is a supervised learner that provides optimal solution than other neural networks. PNN structure consist of four layers such as input layer, pattern layer, summation layer and output layer [28].Input layer provides the data to the structure. Pattern layer calculates the probability by adjusting threshold value. Summation layer add the calculated probability. At last output layer performs voting by selecting the largest value to categorize the data of different classes.

F. Proposed Method

In this work, we proposed an efficient and reliable computational model for face recognition. Features are obtained from both face datasets by employing PCA based feature extraction technique. The performance of the proposed model is measured by using different nature of classification algorithms such as SVM, PNN and Random Forest. 10-fold cross validation test is used to enhance the performance of classification algorithm. Various performance measures are used to evaluate the performance of the classification. Block diagram of the proposed system is depicted in figure 3.

Different performance measures are used for assessing the performance of classification algorithm, which are mention below.

$$Accuracy = \sum_{i=1}^{k} \frac{TPi}{N} \quad (3)$$

$$Sensitivity = \left(\frac{TP}{TP} + FN\right) * 100 \quad (4)$$

$$Specificity = \left(\frac{TN}{FP} + FN\right) * 100 \quad (5)$$

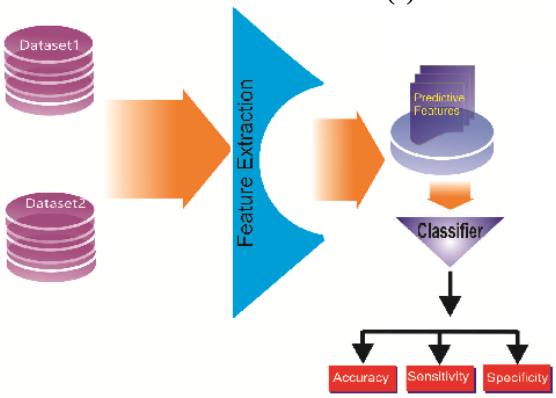

Figure 3. Block diagram of the proposed system

III. RESULTS AND DISCUSSION

Different cross validation tests such as self-consistency, jackknife, and independent tests are used by the researchers to enhance the performance of the classification algorithms. In this work we have utilized 10-fold cross validation test to minimize computational cost and to reduce classification errors. In 10-fold cross validation test, one fold is used for testing and remaining folds are used for training. The whole process is repeated ten times and finally the prediction results are combined.

In this work we have used PCA based feature extraction technique to extract valuable information from two different nature face datasets.

Table1. Success rates of classifiers using PCA feature space

The prediction performance of classification algorithms using PCA based feature space are reported in Table1 and Table 2. In case of RF obtained an accuracy of 80%, sensitivity of 79%

and specificity of 79%. Likely, SVM achieved the prediction performance of 76% with sensitivity, specificity of 74% and 78% respectively. Finally PNN achieved the highest accuracy of 92%, having 96% sensitivity and 98% specificity. On other hand Dataset 2, yielded an accuracy of 81%, sensitivity of 85% and specificity of 78% using RF. In case of SVM, Our proposed model obtained an accuracy of 68%, sensitivity of 69% and specificity of 92%. Still, PNN has achieved remarkable prediction rate as compared to other classification learners by achieving 94% accuracy, 97% sensitivity and 92% specificity.

(Acc= Accuracy, Sen: Sensitivity, Sp: Specificity)

IV. CONCLUSION

In this paper, we proposed a reliable and computationally efficient model for face recognition. Numerical features are obtained from face images using PCA. Features vector are preprocessed in order to remove noisy and irrelevant features. The performance of the extracted feature vector is evaluated using three different nature of classification learners such as SVM, PNN and RF. The proposed model is tested on two different face datasets. Among used classifiers, PNN reported the highest prediction accuracy of 92% and 94% on dataset 1 and dataset 2, respectively

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