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Technique to Hybridize Principle Component and Independent Component Algorithms using Score Based Fusion Process

Rupinder Kaur[1] , Dr. Pardeep Kumar[2] , Ms. Shalini Aggarwal[3]

[1]Department of Computer Science & Applications, Kurukshetra University, Kurukshetra
[2]Assistant professor, Department of Computer & Application, Kurukshetra University, Kurukshetra
[3]Assistant professor, Computer Science,GCW, Karnal

Abstract – *The performance gains presented by these new descriptors have led to significant growth in applying texture methods to a large variety of computer vision problems. In this paper, a hybrid face recognition approach has been used. Hybrid approach has a unique significance in Face Recognition Systems. They join different face detection techniques to achieve a better result as compared to single method. This paper presents hybridization between two face recognition techniques i.e. principle component analysis and independent component analysis. A score based approach has been used as a combiner process to hybrid these face recognition techniques. The experimented results show that the hybrid system has higher score value than face recognition systems using single method.*

Key Words: **Face Recognition, PCA, ICA, BPNN and Score based strategy**.

1.INTRODUCTION

The surveillance became a big challenging problem in the present world. Sake of security purpose in phone, banks or other public places there are different number of security systems such as password, finger prints and pattern recognitions. The pattern or passwords used can be trapped easily once if the user or the pattern is well known. The finger print system doesn't achieve full-fledged result the through put is low because of the miss matches or a layer of distraction due to external sources and many other reasons. To provide a proper surveillance we are going for face recognition, here unique features of each individual are taken into consideration.

Face recognition concept of feature [1] extraction and detection, is a small capacity for human beings. Human have [1] developed this skill to correctly and instantaneously recognize effects around us after millions of years of evolution. Implementations in computers are much more difficult task although not impossible.

A characteristic face recognition system includes the following steps:

1. From dataset of images Evaluate the face area ,i.e. identify and position face
2. Find a appropriate illustration of the face area, i.e. feature extraction; and
3. Categorize the representations.

It is supposed that human face has been evaluated from dataset images with the help of methods that are mention in [2]. The intend of this study is focus on only steps 2 & 3.

2. Proposed Face Recognition Technique Algorithm PCA and ICA

Face recognition system generally uses only one feature extraction method and one classifier. Normally as a classifier neural network are used called conventional method known as Single Feature Neural Network (SFNN) face recognition as shown in Fig. 1.

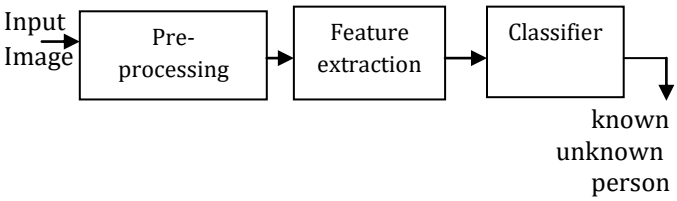

Fig.1: SFNN Face recognition system

The Proposed face recognition as shown in Fig.2.

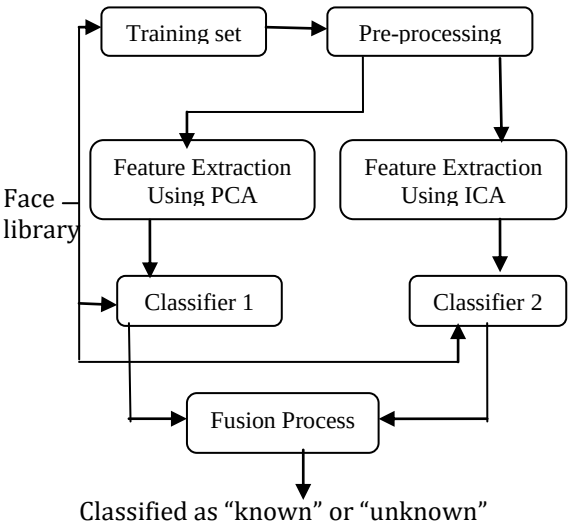

Fig. 2: Hybrid Multi-Feature Face recognition system.

Figure 2 have four phases. In the first phase, pre-processing [3] has been performed by resize the face image, adjusting clarity. In the second phase, meaningful features are extracted by using two techniques PCA and ICA in parallel form. In the third step, classification method has been applied that classified a given input face image. In this a back propagation neural network has been used for classification. In the last phase, the output of both classifiers has been combined by using score based approach to create the class label of given input image(s).

2.1 Feature Extraction

Feature extraction methods are used to extract the significant features form the face images. It reduces the high dimensional data to lesser dimensions. The hybrid approach contains N different feature domains evaluated from the normalized face images. Hence this system can extract more features of face images for classification reason. In this paper two feature extraction method has been used PCA and ICA.

2.2.1. Principal Component Analysis

PCA is an appearance based face recognition method that divides face images into a small number of feature images known as "Eignfaces" which also called principle components[4].

In order to decompose, the significant information from face image has been extracted

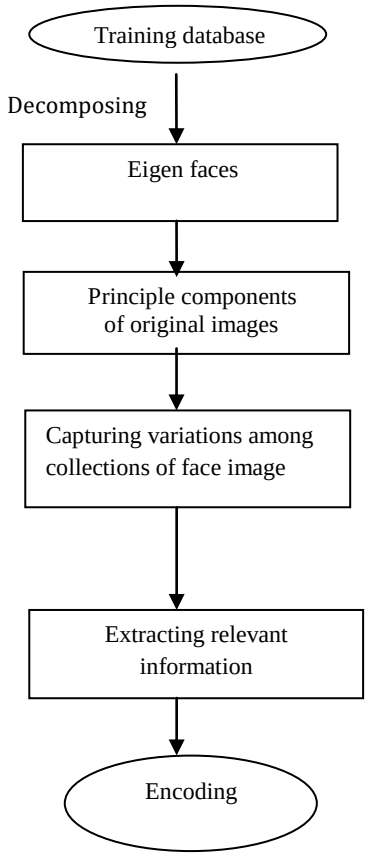

Fig. 3a): Decomposing the training face images

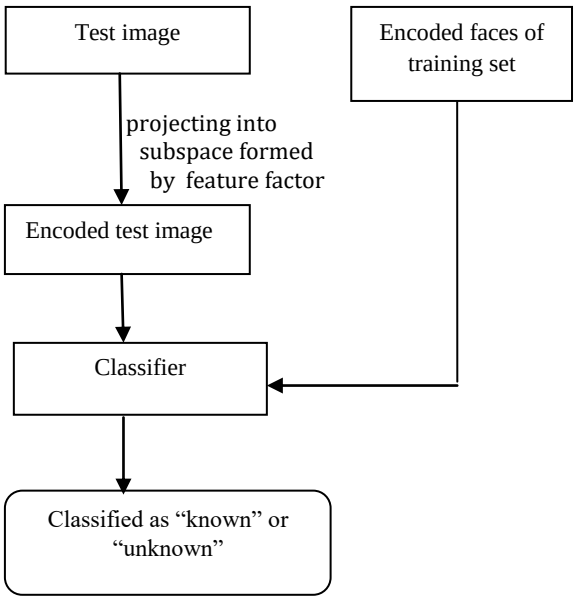

Fig. 3b): Classification of the input face image

The algorithm is as follows

Step 1: Define training dataset
Let T_i is the training set of images (i=1… N)

Step 2: Calculate the mean of training dataset by using formula below given:

$\Psi = 1/N \sum^{N}_{i=1} T_i$, Where Ψ is average face vector.

Step 3: Now subtract the training set by the mean image to calculate deviation in which each image differ from the mean image:

$\Phi_i = T_i - \Psi$ (i=1… N)

Step 4: Obtaining the co-variance matrix by

$C=B.B^T$

Where the matrix B is as shown below

$B= [\Phi_1, \Phi_2, \Phi_3 ..... \Phi_N)$

Step 5: Calculate the eigenvectors and eigenvalues of C.
PCA is applied to large vectors that are defined in the previous covariance matrix, which produce a set of N orthogonal vectors $V_{1.....}V_{N.}$

Step 6: Obtain the weight vector of the facial image T.

$W_k= U^T_k (T- \Psi)$

To classify an input image following steps performed.

Step 7: Convert test image into vector T

Step 8: Converts test image into Eigen faces components "face space".

$W_k= U^T_k (T- \Psi)$, here k=1,....,N'

Where N'≤N is the no of eigen faces used for recognition.

$\Omega^T= (W_1, W_2, W_3 ...W_{N'})$.

The feature vectors that are evaluated from training set or test image are used to train or simulate the neural network.

2.2.2. Independent Component Analysis

ICA can be used to produce a statistically independent basis vectors. ICA minimizes the second-order and higher-order dependencies subspace. The principle of ICA algorithms are: to extract face feature vectors, to do face recognition, for face feature compression. . The main scheme of ICA is that any face image is unique linear combinations of unknown independent signals that are obtained in ICA.

$P=UQ \Rightarrow Q= W1\ P$ where $W1 = U^{-1}$

In this, P = face images, U = unknown mixing matrix and Q= statistically independent

The training face images have been divided into statistically independent basis images as shown in Fig.4. This information is utilized to encode the input face image and compare individuals as shown in Fig. 3b.

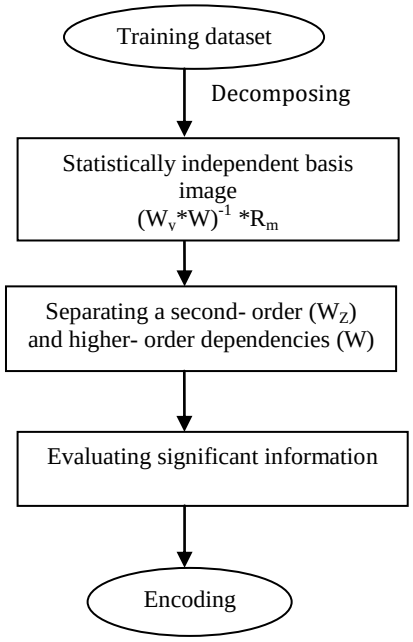

Fig. 4: Decomposing the training face images

The algorithm is as follows

In this algorithm, assume that the dimensionality are already reduced by applied the reduction method using PCA on training images.

The below algorithm produce the $W1= W_y*W$ Where W_y is a whitening matrix and W is a learning matrix.

Step 1: Define training dataset T

Subtract the training dataset T by the row means and then T is passed through the second order dependencies filter also called Whitening filter.

Whitening: $W_y = V \times (E)^{-1/2}$

Where V and E are eigenvectors and eigenvalues respectively.

This step discards the first and second order dependencies in the dataset.

Step 2: In this step we calculate the higher-order dependencies (W)

Here, a series of pass through dataset T obtained until old value of W and new value of W points in same direction refer to [5].

Step 3: Calculate W1

$W1 = W_y \times W$

Step 4: Calculate independent component.

$A = P * W1^{-1}$

To classify an input image following steps performed.

Step 5: convert Test image into Eigenfaces (if dimension reduction PCA already applied to ICA).

Step 6: determine coefficient A_{test}

$A_{test} = P_{test} * W1^{-1}$

Both A and A_{test} that are evaluated in training set and test image are produce feature vectors. These feature vectors are used in neural network for training and simulating the network respectively.

2.3. Classification

The Back Propagation Neural Network is most popular and extensively used multilayer perceptrons (MLP). This learning algorithm consists of set of source nodes called input layer, hidden layer and output layer. BPNN is multilayer feed-forward possessed a gradient descent scheme. For face recognition the input layer posses the image pixel values from the face image. The output layer posses to classes or individuals in the database. The main aim of BPNN is to maintain stability between quick responses and good responses. This classifier is defining as below:

Step 1: Gather both input and output training data.

Here, Eigen faces and independent components that are produced in PCA and ICA are taken as input. And output layer consist as array in which rows are face images and column are feature considered

Step 2: construct neural network and define its parameters.

Step 3: Train the neural network as declare in [6].

Step 4: possessed the network reaction to an input image (s).

Now, the outputs (results) of both neural networks are applied to fusion process which is called combiner.

2.4. Fusion Process

"Two heads are superior than individual could be the centre principle of fusion.

In this paper, for both systems PCA and ICA a single classifier called neural networks are used for classification, therefore the outputs of both systems PCA and ICA are in same layout. Thus score based strategy is used as a combiner [7].

The algorithm is as follows

Step 1: Gather or assemble the output of both classifiers

Step 2: define noise value

Step 3: If both PCA and ICA classifiers classified an input image to similar class tag then

If PCA score value > noise value and ICA score values > noise value then

Either PCA/ICA class tag the input image is classified and return

Else

Refuse access and return

End

Goto step 4

End

Step 4: If PCA score value > ICA score value and PCA (MSE) <ICA (MSE) then

IF PCA score value>noise value then

PCA class tag is classified as an input image return

Else

Refuse access and return

End

Else

Goto step 5

End

Step 5: If ICA score value > noise value

ICA class tag is classified as an input image and return

Else

Refuse access and return

End

3. SIMULATION RESULTS

The experimental results of the implementation are offered in this section. The simulation of the recognition technique was simulated on MATLAB. The proposed technique is simulated on ORL face database. We have created face database. The database has been separated into two parts: training and testing database. Training of network is done on train images and test image is fed to the network as input image. In ORL face database, there are total 40 images, each subject having 10 images of single person with different pose, illumination and face expressions.

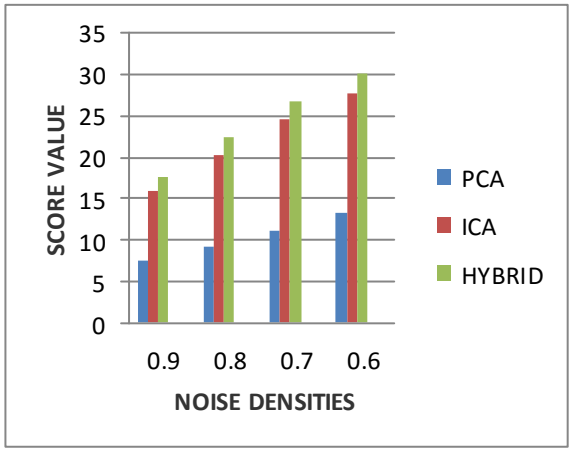

Fig5 Shows the score value of PCA, ICA and HYBRID method

Table 3.1: Score value comparison of PCA, ICA and Hybrid method

Noise level	PCA Score Value	ICA Score Value	Hybrid Score Value
0.9	**7.6482**	**15.9714**	**17.5548**
0.8	**9.1413**	**20.2127**	**22.331**
0.7	**11.0225**	**24.6628**	**26.8838**
0.6	**13.2709**	**27.7758**	**30.2495**

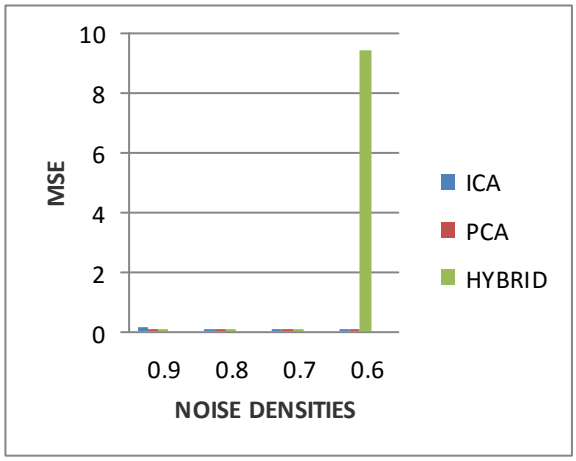

Fig6 Shows the MSE value of PCA, ICA and HYBRID method

Table 3.2: Mean square error comparison of PCA, ICA and Hybrid method

Noise level	PCA MSE	ICA MSE	HYBRID MSE
0.9	**0.1713**	**0.0255**	**0.0177**
0.8	**0.1219**	**0.0095**	**0.0058**
0.7	**0.0790**	**0.0034**	**0.0020**
0.6	**0.0471**	**0.0013**	**9.4417**

4. CONCLUSION

This paper shows that the individual PCA is weaker than the individual ICA because PCA is based on second order dependencies on the other hand ICA is based on second order and higher order dependencies. This paper conclude that the hybrid Approach has higher score value than the individual PCA and ICA. Mean square error (MSE) of hybrid Approach has also low rate as compared to individual PCA and ICA. As "Two heads are superior than individual", Hybrid method gives better performance than both a simple PCA and ICA implementations.

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