Advance Algorithmic Approach for Face Recognition

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Abstract- For enhancing the performance and accuracy of biometric face recognition system, we proposed a multi-algorithmic approach, where in a combination of different algorithms is used. We implemented four face recognition systems based on Principal Component Analysis (PCA), Discrete Cosine Transform (DCT), Template Matching using Correlation and Partitioned Iterative Function System (PIFS) fractal codes. We fuse the scores of these techniques, because fusing the scores of several different techniques applied on the same data (face image) is a very promising approach to improve the overall accuracy of the biometric systems [14]. We made different combinations (Multi-algorithmic approach) of these techniques in a group of two (PCA+DCT, PCA+Corr, PCA+PIFS, DCT+Corr, DCT+PIFS, PIFS+Corr), group of three (PCA+DCT+Corr, PCA+DCT+PIFS, PCA+Corr+PIFS, DCT+Corr+PIFS) and a group of four (PCA+DCT+Corr+PIFS). We compute the results of these different combination based systems to find which combination gives the highest recognition rate. We experiment with the standard database namely Olivetti Research Laboratory face database. ORL database contains a set of faces taken between April 1992 and April 1994 at the Olivetti Research Laboratory in Cambridge, U.K. [28].

Keywords – Factal, PCA, DCT, PIFS

I. INTRODUCTION

With the progress of technology, the people pay more attention to the biometric recognition technology. Compared with other biometric identification technologies (such as finger print, DNA testing etc), a personal identification system based on the face patterns is regarded as one of the most promising biometric recognition technologies because of its convenience, rapid identification, high user acceptance, prominent recognition accuracy and difficult to counterfeit. Face recognition technology has numerous commercial and law enforcement applications. These applications range from static matching of controlled format photographs such as passports, credit cards, photo ID's, drivers license's, and mug shots to real time matching of surveillance video images [10].

II. A STUDY OF FACE RECOGNITION APPROACHES

For over two decades [15] face recognition has drawn attention of the research community. With the synergy of efforts from researchers in diverse fields including computer engineering, mathematics, neuroscience and psychophysics, different frameworks have evolved for solving the problem of face recognition.

PCA is also known as Eigenface method. In PCA method the images are projected onto the so called eigenspace [8] that best encodes the variations among known facial classes. In mathematical terms, we wish to find the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images, treating an image as a point (or vector) in a very high dimensional space. The eigenvectors are ordered, each one accounting for a different amount of the variation among the face images.Recognition technique formulated on Partitioned Iterated Function System (PIFS) [9] makes use of the fact that human face shows region-wise (fractal) self-similarity, which is utilized for encoding the face to generate the PIFS code. Recognition is performed by matching these PIFS codes. DCT is used to extract the features from images. To get the feature vector representing a face, its DCT coefficients are determined and only a subset of the DCT coefficients is retained. This feature vector contains low to mid frequency DCT coefficients, as these are the ones containing highest information [7]. To recognize a particular input query face, the system compares the face's feature vector to the feature vector of the database faces using Euclidean Distance nearest neighbor classifier.

III. Implementation of Face Recognition Algorithms Using MATLAB

In this chapter we will discuss the implementation steps of face recognition systems based on Principal Component Analysis (PCA), Discrete Cosine transform (DCT), Template Matching using Correlation and Partitioned Iterative Function System (PIFS).

3.1 Principle Component Analysis (PCA)

3.1.1Implementation steps using MATLAB:

For implementing face recognition system based on PCA in MATLAB, we follow the steps listed under:
Step 1: Face preprocessing
Step 2: Feature vector extraction
Step 3: Recognition step

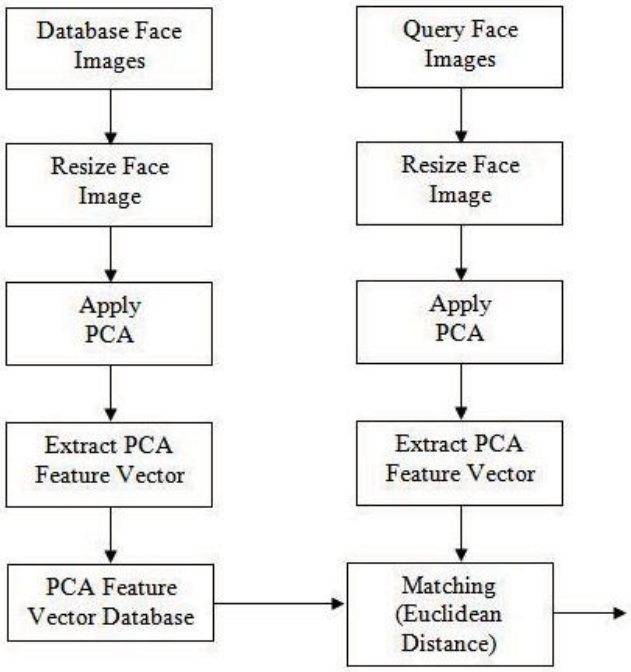


Fig 3.3 Flow chart of face recognition system based on PCA

3.2 Discrete Cosine Transform

3.2.1 Implementation steps using MATLAB

For implementing face recognition system using Discrete Cosine Transform, we follow the steps listed under:
Step 1: Face preprocessing
Step 2: Feature extraction
Step 3: Recognition Step

3.3 Template Matching using Correlation

Template matching is the process of locating the position of a sub image inside a larger image. The sub image is called the template and the larger image is called the search area.

3.3.1 Implementation steps using MAT lab

For implementing face recognition system using Template matching, we follow the steps listed under:
Step 1: Face preprocessing
Step 2: Template Creation
Step 3: Recognition step

3.4 Partitioned Iterative Function System Fractal code (PIFS)

PIFS is collection of transformations w_i. Each transformation w_i is applied to a part of image, $w_{i,\,can}$ be written as:

$$w_i\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} a & b & 0 \\ c & d & 0 \\ 0 & 0 & s \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} + \begin{pmatrix} e \\ f \\ o \end{pmatrix}$$

3.4.1 Implementation steps using MATLAB

For implementing face recognition system using PIFS in MATLAB, we follow the steps listed under:
Step 1: Face preprocessing
Step 2: PIFS code calculation
Step 3: Recognition step

IV. MULTI ALGORITHM APPROCH

In multi-algorithmic approach, we made the combinations of two, three and four of the above mentioned algorithms as listed under.

(i)Combinations of two:
Six combinations are formed as listed under;
PCA+DCT, PCA+Corr, PCA+PIFS, DCT+Corr, DCT+PIFS, PIFS+Corr

(ii)Combinations of three
Four combinations are formed as listed under;
PCA+DCT+Corr, PCA+DCT+PIFS, PCA+Corr+PIFS, DCT+Corr+PIFS

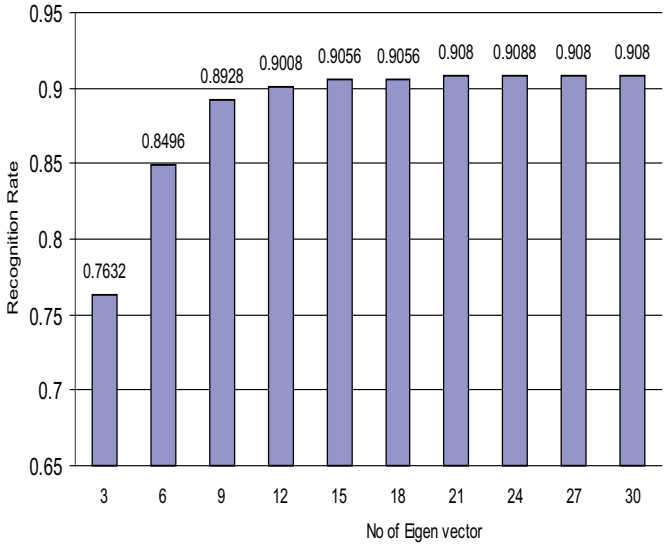
(iii)Combination of four:
PCA+DCT+Corr+PIFS

V. RESULTS AND DISCUSSIONS

Recognition rate results are obtained at two levels,
(i) At top 5-IDs
(ii) At top 10-IDs

5.1Results at level Fist (Top 5-IDs):

5.1.1 Effect of varying the number of eigenvector on the recognition rate:



5.1.1Effect of varying number of eigenvectors at top 5-IDs

5.1.2 Effect of varying the number of DCT coefficients on the recognition rate:

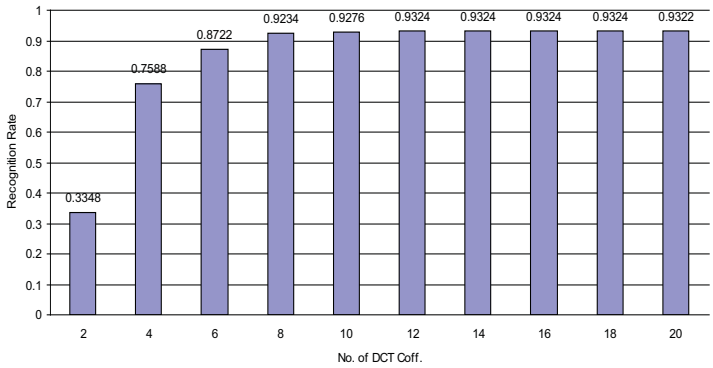


Fig 5.1.2 Effect of DCT coefficient on the recognition rate at top 5-IDs

5.1.3 Results of face recognition systems based on the individual techniques:
The experimental results of face recognition systems based on the individual techniques at top 5-IDs are shown in the figure below.

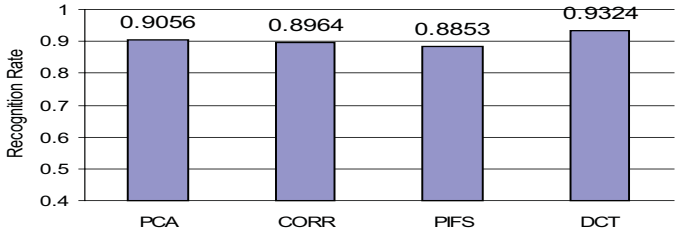


Fig 5.1.3 Recognition rate at top 5-IDs of the four individual techniques

5.1.4 Results of recognition rate for group of three (four combinations):

When, we combine these four individual techniques in a group of three, four combinations namely PCA+DCT+Corr, PCA+DCT+PIFS, PCA+PIFS+Corr, and DCT+PIFS+Corr are obtained.

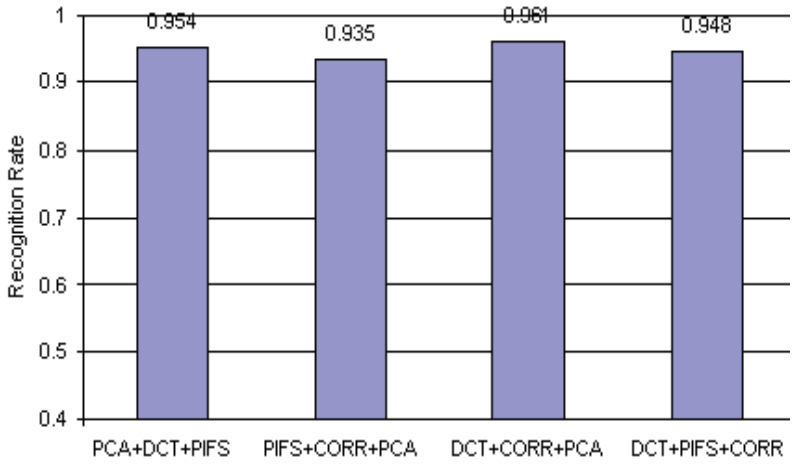
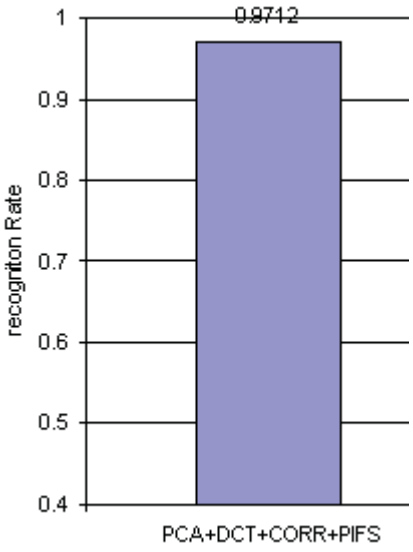


Fig. 5.1.4 Recognition rate of systems based on combination of three at top 5-IDs

5.1.5 Results of face recognition system based on group of four :



5.2 Results at level 2nd (Top 10-IDs):

5.2.1 Effect of varying the number of eigenvector on the recognition rate:

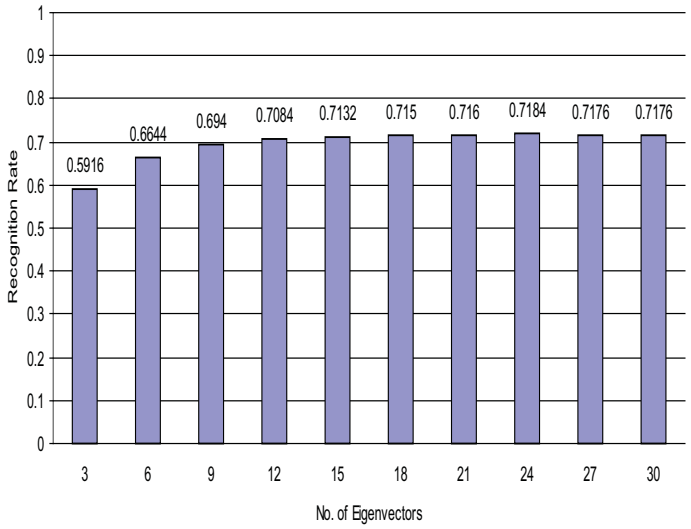


Fig 5.2.1 Effect of varying number of Eigenvectors on recognition rate at top 10-IDs

5.2.2 Effect of varying the number of DCT coefficients on the recognition rate at top 10-IDs:

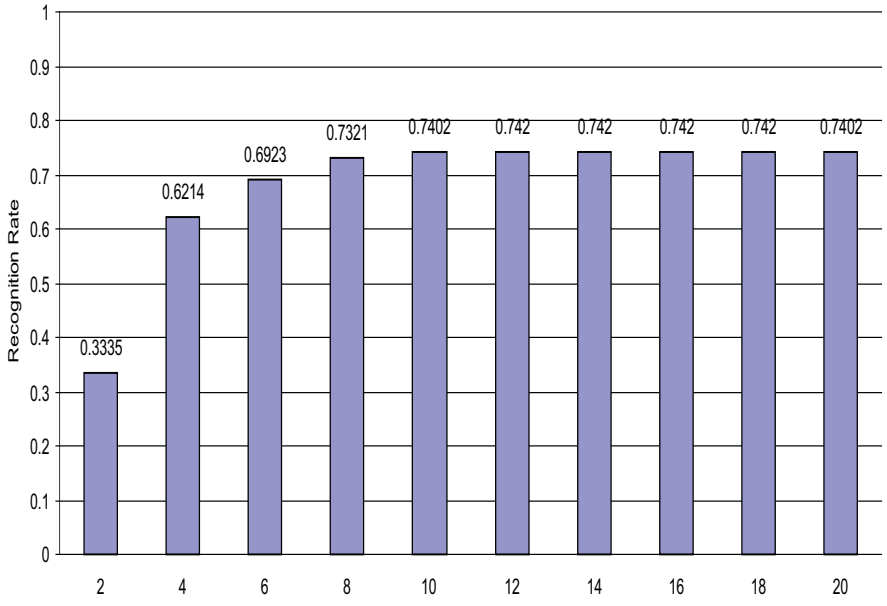


Fig 4.6 Effect of varying DCT coefficient on the recognition rate at top 10-IDs

Fig 5.2.2 Effect of varying DCT Co-efficient on the recognition rate at top 10- ID_S

5.2.3 Results of face recognition systems based on the individual techniques:

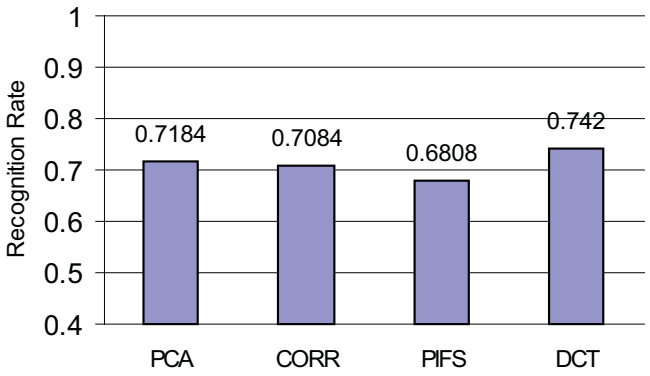


Fig 5.2.3 Recognition rate at top 10-IDs of the four recognition systems

5.2.4 Results of recognition rate for group of three (four combinations):

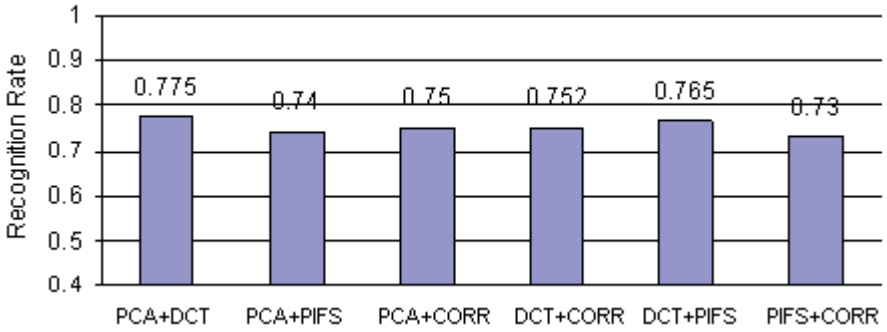


Fig 5.2.4 Recognition rate of systems based on combination of two at top 10-IDs

5.2.5 Results of recognition rate for group of three (four combinations):

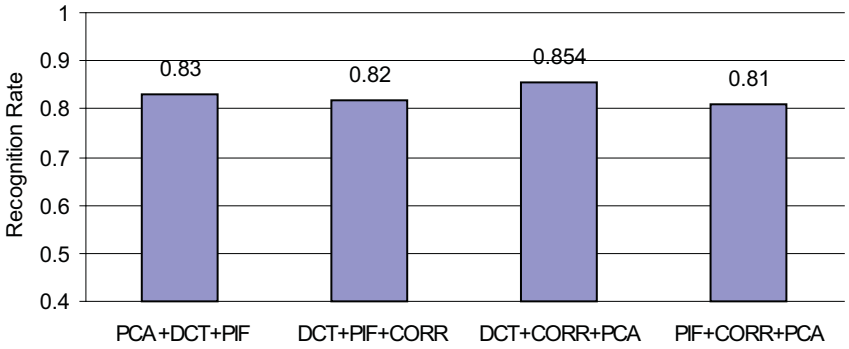


Fig.5.2.5 Recognition rate of systems based on combination of three at top 10-IDs

5.2.6 Result of face recognition system based on group of four:
The top 10-IDs result for PCA+DCT+PIFS+Corr based system i.e. when all the four individual techniques are combined together is as follows.

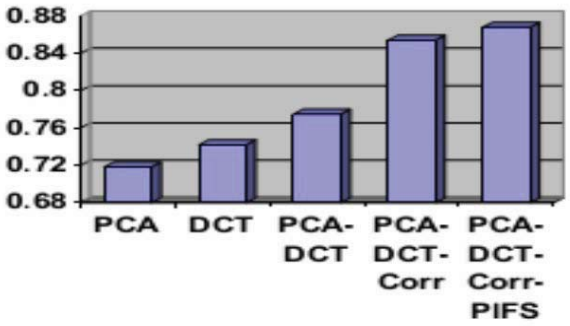


Figure 5: Face Recognition rate of five systems at top 10-IDs

VI. SUMMARY

In this chapter we discussed the results of face recognition systems based on the individual techniques and the results of the systems based on the different combinations of these techniques.

VII. CONCLUSION

The important findings of this work may be summarized as follows.

1.When we compute the recognition rates the four recognition systems based on four individual techniques namely PCA, DCT, Correlation and PIFS at two levels namely at top 5-IDs and top 10-IDs, we find that the DCT based face recognition systems outperforms the other three face recognition systems as it has higher recognition rates in both cases.

2. In the multi-algorithmic approach, we combine these four individual techniques in a pair of two to obtain six combinations namely PCA+DCT, PCA+Corr, DCT+Corr, DCT+PIFS, PIFS+Corr, and PIFS+PCA. Experimentally, we find that these combinations based systems provide better results than the corresponding individual techniques based system. The obvious reason for this is that the some IDs are returned by first system but not by the 2nd system in the pair and vice versa. When we combine these two techniques, these IDs got combined and the recognition rate in both the cases i.e. for the top5-IDs and for the top10-IDs increases. Out of these six combinations, the PCA+DCT based system has the highest recognition rate in both the cases i.e. for the top5-IDs and for the top10-IDs.

3. In another multi-algorithmic approach, we combine these four individual techniques in a group of three to obtain four combinations namely PCA+DCT+Corr, PCA+DCT+PIFS, PCA+PIFS+Corr, and DCT+PIFS+Corr. Experimentally, we find that these combinations based systems provide better results than the corresponding individual techniques based systems and also perform better than the corresponding combinations of a pair of two in both the cases i.e. for the top5-IDs and for the top10-IDs. The reason for this is that the addition of the third technique improves the efficiency of the corresponding combination of the pair of two techniques. Out of these four combinations, PCA+DCT+Corr have the highest recognition rate in both the cases i.e. for the top5-IDs and for the top10-IDs.

4.With the observation that addition of a technique only improves the recognition accuracy of a combination of techniques in the multi-algorithmic approach, we proposed to combine all these four individual techniques together i.e. PCA+DCT+PIFS+Corr. Experimentally, we find that the system based on this combination of four individual techniques provides the highest recognition rate in both the cases i.e. for the top5-IDs and for the top10-IDs in comparison of the all other systems based on individual techniques or a combination of two or three techniques.

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