



ANALYSIS OF FACE RECOGNITION USING MULTI-ALGORITHMIC CONCEPTS

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ABSTRACT

Face recognition is use as a human validation mode for human authorization or authentication. Face recognition is a method of retrieving the faces of similar types from the face databases. It is the problem of finding a face in the target database to find a face that correspond a given face. The aim of face recognition is to find a face in the database, which has highest similarity with a given face. The job of face recognition involves the mining of different traits of the human face from the face picture/image for discriminating it from other people. Many face recognition concepts have been developed for applications such as access control and surveillance. For enhancing the performance and accuracy of face recognition, we use the multi-algorithmic concepts, where in a combination of different face recognition algorithms is used. We implemented four well known face recognition algorithms, they are following: (i) Principal Component Analysis (PCA), (ii) Discrete Cosine Transform (DCT), (iii) Template Matching using Correlation and (iv) Partitioned Iterative Function System (PIFS). We fuse the scores of these algorithms, because fusing the scores of a number of different algorithms applied on the identical data (face image) is a very promising concept to improve the overall performance of the face recognition concepts. We fuse the scores of above face recognition algorithms in a combination of two develop six multi-algorithmic concepts of face recognition. Also, fuse the scores in a combination of three and four develop five multi-algorithmic concepts of face recognition. In this work, we analyze the performance of eleven multi-algorithmic concepts. We present a comparative study of face recognition rate of eleven face recognition concepts at two different precision levels namely at top- 5 and at top-10. We test with a standard database called ORL face database. Experimentally, we find that the concept based on the combination of four outperforms the concept based on the combination of three. Similarly, the concept based on the combination of three outperforms the concept based on the combination of two.

Keyword: DCT, Face Recognition, face recognition rate, Multi-algorithmic concepts, ORL face database, PCA, PIFS, and Template matching using Correlation.

I. INTRODUCTION

In the face recognition, a given face is compared with the faces stored in a face database in order to recognize the individual. The aim is to find a face in the database, which has the highest similarity with the given face. Most successful forms of the person authenticity are the facial recognition. In the fields of biometric, facial



recognition technology is one of the greatest rising fields. Several studies have been reported in the last 10 to 15 years given in [5, 6, 7 and 9]. Researchers are still going on the development of more accurate and reliable face recognition concept. With collective efforts from researchers in different fields including computers, mathematics, psychophysics and neuroscience, different views have developed to resolve the problem of face recognition [6] and [7]. Among these, the analytical approaches are those based on Principal Component Analysis (PCA), Discrete Cosine Transform (DCT), Template Matching using correlation, Partitioned Iterated Function System (PIFS). For enhancing the accuracy and to increase the performance of the face recognition concept a combination of these algorithms can be used [12] and [13]. In this paper, we discuss the eleven different face recognition concepts based on in the combination of two, three and four individual face recognition algorithms (discussed above). The goal is to find the combination of four performs better than the combination three, and the combination of three performs better than the combination of two in terms of recognition rate. This paper is organized as follows: In section 2, we discuss in short the earlier studies performed in the field of face recognition approaches. In section 3, we give an overview of the face database (ORL) used. In section 4, we present the multi-algorithmic concepts of face recognition in the combination of two, three and four algorithms. In section 5, we show the steps of implementation of face recognition concepts with intermediate outcomes. In section 6 we analyze our experimental results at two precision levels. Finally, we conclude the work and give few future guidelines.

II. RELATED WORK

On the investigation of face recognition concept some of the main studies on face recognition concepts are discussed below:

PCA also known as Eigen face method, In PCA method the images are projected onto the facial value so called eigen-space [10] and [12]. The eigenvectors are ordered, each one reporting for a different quantity of the disparity among the face images. These eigenvectors can be consideration of as a set of traits that together characterize the disparity between face images. Each image location gives more or less to each eigenvector [1, 2, 3 and 4]. PCA approach reduces the measurement of the data by means of data compression fundamentals [4] and realizes the most valuable low dimensional arrangement of facial blueprints. This reduction in measurement removes information that is not useful [5] and precisely crumbles the face structure into unassociated mechanism known as eigenfaces.

For representing a face using DCT to get the feature vector, its DCT coefficients are resolved and only a sub-set of the DCT coefficients is preserved. This feature vector has low to mid frequency DCT coefficients, as these are the ones having highest information [6]. Illumination normalization is recommended by using the correlation of discrete cosine transform (DCT) low-frequency coefficients to enlightenment [14]. The input image contrast is stretched using the method of full image histogram equalization. Then, to compensate the illumination variations the low-frequency DCT coefficients are re-scaled to lower value.

Face recognition based on template matching represents a face in terms of a template consisting of several surrounding masks the projecting traits e.g. the mouth, the eyes and the nose [11]. The corresponding pixels

values in two images are two variables, template and source image. A face detection method based on half face-template is discussed in [8].

Recognition technique formulated on Partitioned Iterated Function System (PIFS) makes use of the fact that human face shows self-similarity region-wise, which is utilized for encoding the face to generate the PIFS code, by matching the PIFS codes recognition is performed [13], in which a face recognition based on PIFS representation and matching is carried out in the domain of PIFS code.

The Local feature analysis representations are sparse-distributed and are effectively low-dimensional and maintain all the advantages of the dark demonstrations of the PCA. But, contrasting the global eigenvector, they give a method of items in terms of statistically derived local features (e.g. eye, nose etc.) and their positions [2, 3 and 4].

III. ORL FACE DATABASE

The ORL face database was originally published by Cambridge University. ORL database contains a set of face images taken between April 1992 and April 1994 at the Olivetti Research Laboratory in Cambridge, U.K. [15]. Since 1994, ORL has been used to benchmark many face recognition or classification systems. Same database we had used in our previous works [1, 2, 3, and 4].

It consists of 400 face images taken from 40 persons, 10 images per person. For each person, it contains face images under different brightness conditions, facial expressions, and poses.

The images of ORL are in bitmap file format (bmp), grayscale with a resolution of 92x 112 pixels. There are variations in images of different persons like persons have beard, persons have glasses, persons have moustaches etc.

IV. MULTI-ALGORITHMIC CONCEPTS OF FACE RECOGNITION

In this section, we have discussed the face recognition using multi-algorithmic concepts. We fused the scores of face recognition in the combination of two and three algorithms. Total we have been developed ten multi-algorithmic concepts.

4.1 Face Recognition in the Combination of Two Algorithms

By fusing the scores of two individual face recognition algorithms. First, we have implemented four individual algorithms of face recognition: (i) PCA, (ii) DCT, (iii) Template Matching (Corr) and (iv) PIFS. We have been developed the six possible combinations [1] from these four individual algorithms. They are the following: PCA-DCT, PCA-Corr, PCA-PIFS, DCT-Corr, DCT-PIFS, and Corr-PIFS face recognition concepts.

In this paper, we have discussed only one technique of multi-algorithmic approaches of face recognition in the combination of two named PCA-DCT, because of space limitation. Rest is the identical. Figure 1 shows the block diagram of the PCA-DCT face recognition concept [2] and [4]. Due to space limitation we have shown only one. Block diagrams of the other five are similar. The least minimum Euclidean distance gives closest match with the query face image.

In PCA-DCT concept, first we extract the PCA feature vector and then extract DCT feature vector of the reference face database images. Reference face image database when subjected to Principal Component Analysis, PCA reference feature vector database is obtained. Likewise when the reference face image database is subjected to DCT, Template matching and PIFS, DCT reference feature vector database, Template matching reference feature vector database and reference PIFS code database is obtained respectively. The Discrete Cosine Transform (DCT) converts an image from spatial domain to frequency domain. [3].

4.2 Face Recognition in the Combination of Three and Four Algorithms

By fusing the scores of three individual face recognition algorithms. We have been developed the four possible combinations [1] from the above four individual algorithms. They are the following: PCA-DCT-Corr, PCA-DCT-PIFS, PCA-Corr-PIFS, and DCT-Corr-PIFS face recognition concepts. By fusing the scores of all four individual algorithms we have been developed one concept named PCA-DCT-Corr-PIFS face recognition concept.

Figure 2 shows the block diagram of the PCA-DCT-Corr face recognition concept [2]. Due to space limitation we have shown only one. Block diagrams of the other four are similar. The least minimum Euclidean distance gives closest match with the query face image.

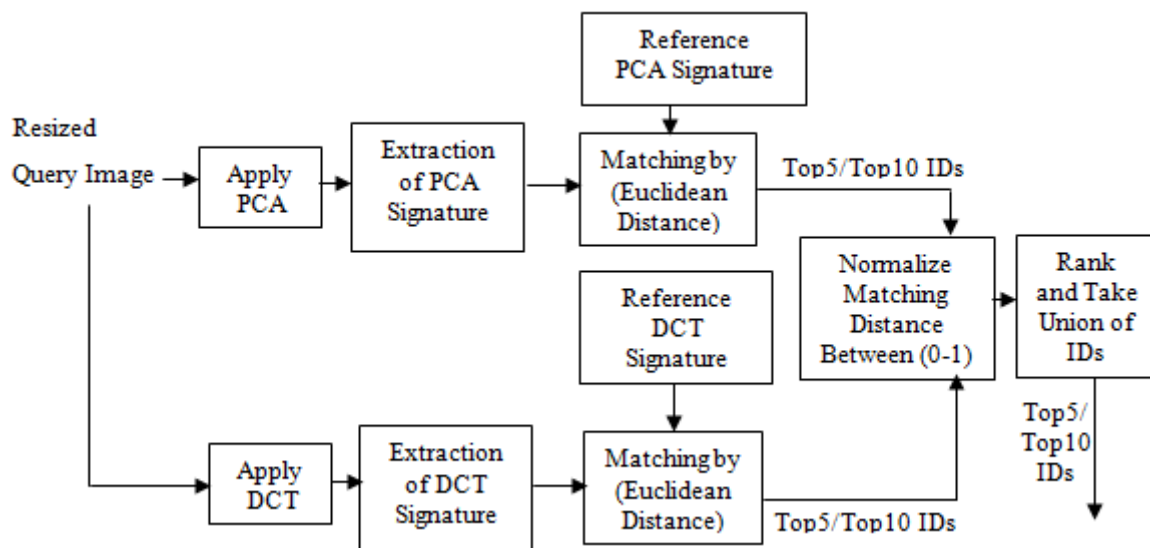


Figure 1: Block diagram of the PCA-DCT concept

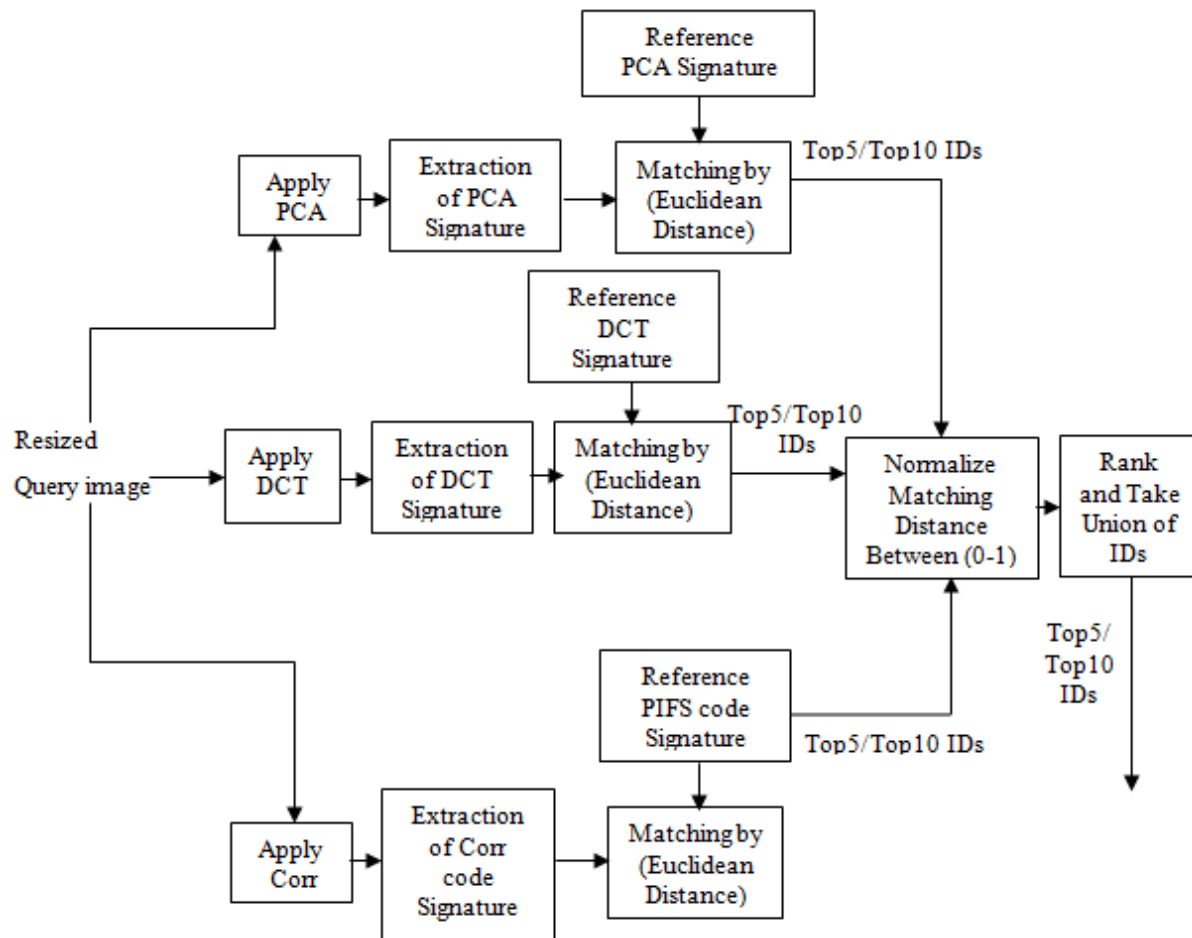


Figure 2: Block diagram of the PCA-DCT-Corr concept

V. IMPLEMENTATION OF FACE RECOGNITION CONCEPT AND INTERMEDIATE OUTCOME

We follow three steps for implementing the face recognition concept that are: (1) Face Resizing steps, (2) Feature vector extraction and (3) Recognition step. In first step, resizing of the images are performed because original images have more values by which eigenface computation becomes complex. ORL face database images size is 92×112 . Hence, after resizing the face image, size is 64×64 . In the feature vector extraction step: in case of PCA, find the eigenvectors with the highest eigenvalue. These eigenvectors can be thought of as a set of features that together characterize the variation between face images. In case of DCT, its DCT is computed and only a subset of the obtained coefficients is retained. This feature vector contains low to mid frequency DCT coefficients, as these are the ones containing highest variance. In Template Matching the templates of eyes, nose and mouth are created and stored as reference Template database. In recognition steps, Euclidean distance classifier is used to find the distance between the query face image feature vector and the reference face image database feature vector [1], [2], [3] and [4].

VI. ANALYSIS OF EXPERIMENTAL RESULTS AT TWO PRECISION LEVELS

To distinguish a particular input query face, the system matches the face's feature vector to the feature vector of the database faces using Euclidean Distance classifier [7]. Figure 3 shows result of top ten close matches of face ID= 234 and pose no. 24 using PCA-DCT multi-algorithmic concept of face recognition.

Template matching is the process of positioning the location of a sub image inside a larger image. The larger image is called the search area and the sub-image is called the template. The template matching process involves shifting the template over the search area and computing the similarity measure between the template and the window in the search area over which the template lies. The correlation between two signals (cross correlation) is a standard approach to feature detection [14] as well as a building block for more suitable recognition techniques. Figure 4 shows the result of top ten close matches of same face id and pose number as the query of PCA-DCT-Corr multi-algorithmic concept of face recognition [16].

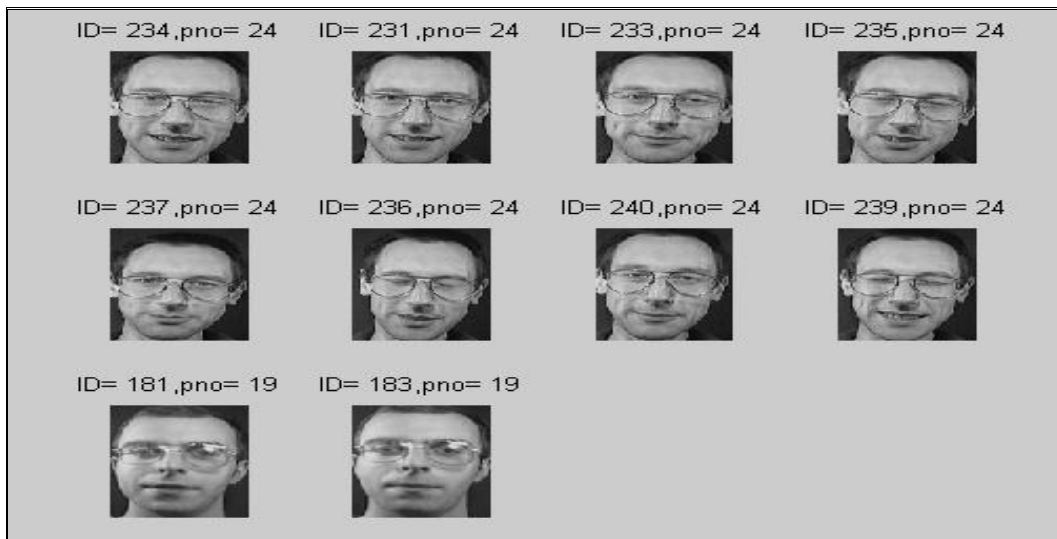


Figure 3: PCA-DCT: Top ten close matches: the first image is the query image

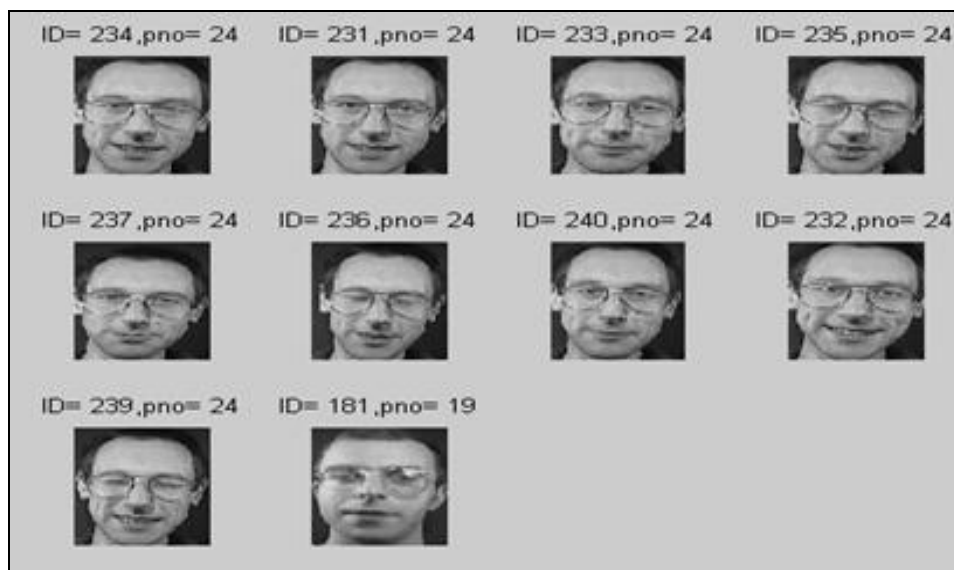


Figure 4: PCA-DCT-Corr: Top ten close matches: the first image is the query image

The experimental results are obtained on Olivetti Research Laboratory (ORL) face image database [15].

- A reference face database of 250 images is created. There are 25 persons, 10 poses corresponding to each person.
- Recognition rate results are obtained at two levels,
 - (i) At top 5-IDs.
 - (ii) At top 10-IDs.
- Each image in the reference face image database is made as query. The top 5-IDs and top 10-IDs are retrieved corresponding to each query image based on minimum matching distance.
- Then the average rate of recognition for system is determined at top 5-IDs and top 10-IDs.
- For implementation, we used MATLAB programming and MATLAB image processing tool box [16].

At top 5-IDs

Table 1 shows the average face recognition rate of six multi-algorithmic face recognition concepts in the combination of two individual algorithms at Top 5 IDs. Table 2 shows the average face recognition rate of four multi-algorithmic face recognition concepts in the combination of three individual algorithms and one multi-algorithmic concept in the combination of four individual algorithms at Top 5 IDs. We find that the PCA-DCT based face recognition concept has higher recognition rate as compared to other five face recognition concepts at this level in the combination of two individual algorithms, and we also find that the PCA-DCT-Corr based face recognition concept has higher recognition rate as compared to other three face recognition concepts at this level in the combination of three individual algorithms. Finally, we find that PCA-DCT-Corr-PIFS has the highest recognition rate at this level, graphically shown in Figure 5 and Figure 6. In the respective figures, the x-axis shows the face recognition rate and the y-axis shows the multi-algorithmic face recognition concept.

Table 1: Face Recognition rate at top 5-IDs of the six multi-algorithmic face recognition concepts

S. No.	Multi-algorithmic Face Recognition Concepts	Face Recognition Rate (%)
1	PCA-DCT	0.9424
2	PCA-Corr	0.9260
3	PCA-PIFS	0.9240
4	DCT-Corr	0.9410
5	DCT-PIFS	0.9380
6	Corr+PIFS	0.9100

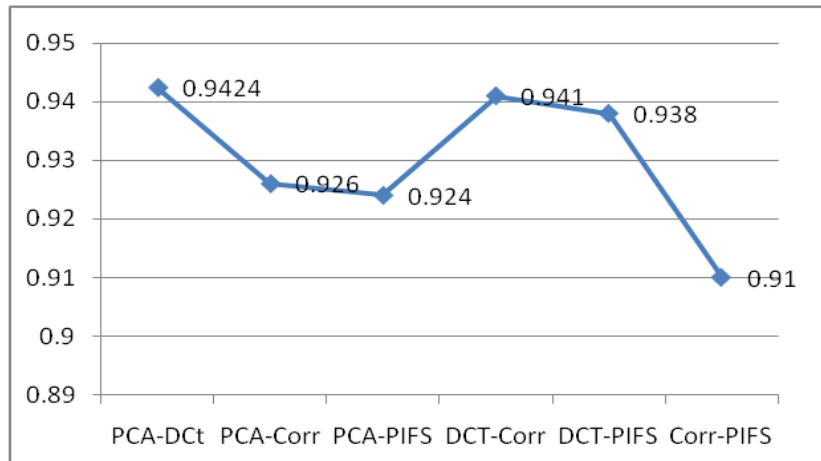


Figure 5: Face Recognition rate at top 5-IDs of the six multi-algorithmic face recognition concepts

Table 2: Face Recognition rate at top 5-IDs of the five multi-algorithmic face recognition concepts

S. No.	Multi-algorithmic Face Recognition Concepts	Face Recognition Rate (%)
1	PCA-DCT-Corr	0.9610
2	PCA-DCT-PIFS	0.9540
3	PCA-Corr-PIFS	0.9350
4	DCT-Corr-PIFS	0.9480
5	PCA-DCT-Corr-PIFS	0.9712

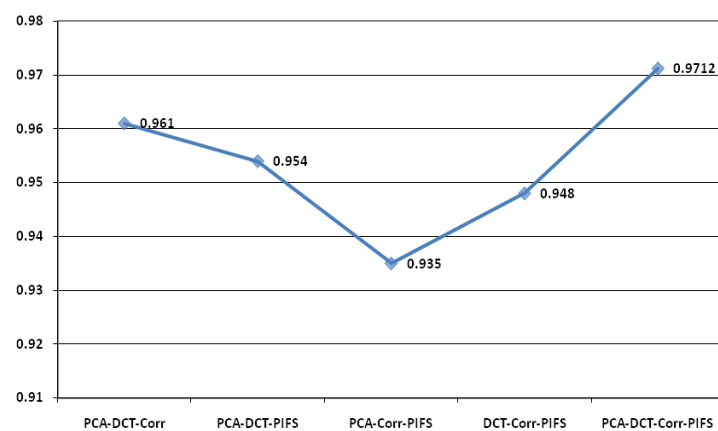


Figure 6: Face Recognition rate at top 5-IDs of the five multi-algorithmic face recognition concepts



At top 10-IDs

Table 3 shows the average face recognition rate of six multi-algorithmic face recognition concepts in the combination of two individual algorithms at Top 10 IDs. Table 4 shows the average face recognition rate of four multi-algorithmic face recognition concepts in the combination of three individual algorithms and one multi-algorithmic concept in the combination of four individual algorithms at Top 10 IDs. We find that the PCA-DCT based face recognition concept has higher recognition rate as compared to other five face recognition concepts at this level in the combination of two individual algorithms, and we also find that the PCA-DCT-Corr based face recognition concept has higher recognition rate as compared to other three face recognition concepts at this level in the combination of three individual algorithms. Finally, we find that PCA-DCT-Corr-PIFS has the highest recognition rate at this level, graphically shown in Figure 7 and Figure 8. In the respective figures, the x-axis shows the face recognition rate and the y-axis shows the multi-algorithmic face recognition concept.

Table 3: Face Recognition rate at top 10-IDs of the six multi-algorithmic face recognition concepts

S. No.	Multi-algorithmic Face Recognition Concepts	Face Recognition Rate (%)
1	PCA-DCT	0.7750
2	PCA-Corr	0.7500
3	PCA-PIFS	0.7400
4	DCT-Corr	0.7650
5	DCT-PIFS	0.7520
6	Corr+PIFS	0.7300

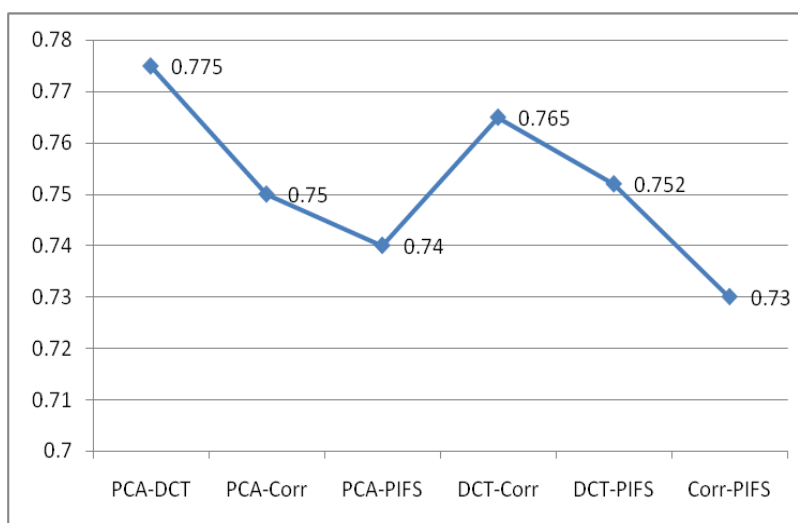


Figure 7: Face Recognition rate at top 10-IDs of the six multi-algorithmic face recognition concepts



Table 4: Face Recognition rate at top 10-IDs of the five multi-algorithmic face recognition concepts

S. No.	Multi-algorithmic Face Recognition Concepts	Face Recognition Rate (%)
1	PCA-DCT-Corr	0.8540
2	PCA-DCT-PIFS	0.8300
3	PCA-Corr-PIFS	0.8100
4	DCT-Corr-PIFS	0.8200
5	PCA-DCT-Corr-PIFS	0.8680

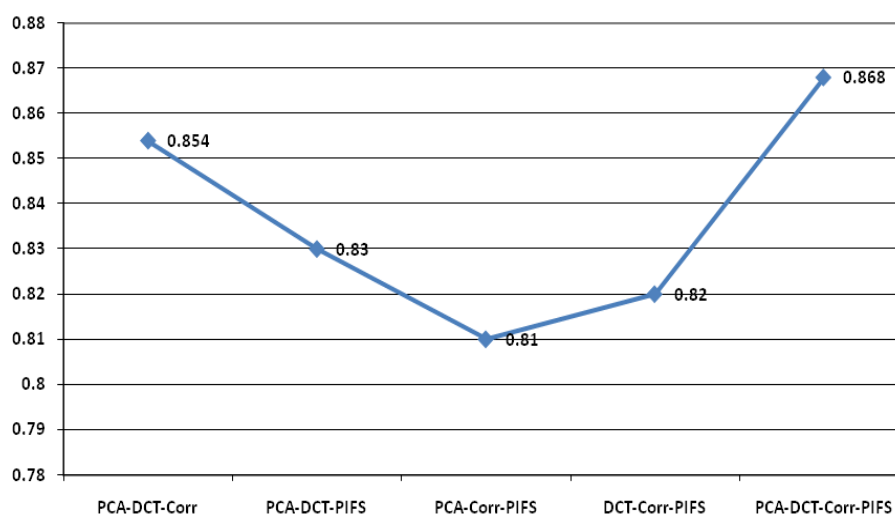


Figure 8: Face Recognition rate at top 10-IDs of the five multi-algorithmic face recognition concepts

VII. CONCLUSION

In this paper, we have analyzed the face recognition using multi-algorithmic concepts. We reported the development of eleven face recognition concepts based on the four individual algorithms namely PCA, DCT, Template Matching using Correlation and PIFS with the combination of two individual algorithms, three individual algorithms and four individual algorithms. In multi-algorithmic concepts, we combined four individual algorithms in a group of two, three and four to obtain eleven combinations namely PCA-DCT, PCA-Corr, PCA-PIFS, DCT-Corr, DCT-PIFS, Corr-PIFS, PCA-DCT-Corr, PCA-DCT-PIFS, PCA-Corr-PIFS, DCT-Corr-PIFS and PCA-DCT-Corr-PIFS. We have tested the eleven face recognition concepts with the benchmark ORL face database, and we computed the average face recognition rates of each concept. Experimentally, we



find that these combinations based concepts (in a group of four) provide better results than the corresponding combination concepts (in a group of three) and the combinations in a group of three return better results than the combinations in a group of two. The observable reason for this is that the some IDs are returned by first algorithm but not by second algorithm in the group and vice-versa. When we combine these two algorithms, these IDs got combined and the recognition rate in both the cases i.e. for the top5-IDs and for the top10-IDs increases. Similar things happened in the combination of three and four algorithms. Out of these eleven multi-algorithmic concepts of face recognition, the PCA-DCT-Corr-PIFS based system has the highest face recognition rate in both the cases i.e. for the top5-IDs and for the top10-IDs. In future we can implement other face recognition algorithms other than these four individual algorithms. In future we can combine other algorithms with our concepts in several different possible combinations.

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