

# Sub Pattern Technique for Face Recognition

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**Abstract** — A Face recognition scheme using sub pattern technique with weighted angle based approach is proposed in this paper. Face recognition is one of the most active research areas in computer vision and pattern recognition with practical application. Feature vector based on Eigen vectors of sub images is used for recognition. Image is partitioned into sub images. Sub parts are rearranged into rows and column matrices. Eigenvectors are computed for these matrices. Global feature vector is generated and weighted angle distance is used for face recognition. Experiments performed on benchmark face database (YALE) indicated that the proposed weighted angle based approach has better recognition performance in terms of average recognized rate and retrieval time compared to existing methods.

**Index Terms**— Sub-pattern, Eigenvectors ,weighted angle

## I. INTRODUCTION

In recent years, face recognition has been the subject of intensive research. With the current perceived world security situation, governments as well as businesses require reliable methods to accurately identify individuals, without overly infringing on rights to privacy or requiring significant compliance on the part of the individual being recognized. Face recognition provides an acceptable solution to this problem. A multitude of techniques have been applied to face recognition and can be separated into two categories geometric feature matching and template matching. Geometric feature <sup>[1]</sup> matching involves segmenting the distinctive features of the face – eyes, nose, mouth, etc – and extracting descriptive information about them such as their widths and heights. Ratios between these measures can then be stored for each person and compared with those from known individuals. Template matching is a non-segmentation approach to face recognition. Each face is treated as a two dimensional array of intensity values, which is then compared with other facial arrays. Earliest methods treated faces as points in very high dimensional space and calculated the Euclidean distance between them

Basically geometric feature images can be partitioned into three categories: In the first type holistic matching <sup>[2]</sup> method (HMM), an image of the whole face is used for pattern recognition <sup>[5]</sup>. One of the most popular is actually the Eigen faces technology. In the second type feature based matching method, it involves local features such as the eyes, nose, and mouth and their geometrical positions are first extracted then their relationship used for

classification. In the Third type hybrid method <sup>[3]</sup> it is also called as human perception system. It involves combined process is whole image Eigenfaces technology and local features of images.

In the mathematical terms of pattern recognition <sup>[4]</sup>, the eigenvector of the co-variance matrix of the set of eigenface images <sup>[5]</sup>, treating as an images of a point (or vector) in a very high dimensional space. The eigenvectors are ordered, each one accounting for a different amount variation among the face images. These eigenvector can be thought of a set of features, which together characteristics the variation among face images. Each image contribute some amount each eigenvector, so that the eigenvector formed from an ensemble of face images appear as a sort of ghostly face images.

Fundamentals of face recognition are discussed in section II. Proposed algorithm is discussed in section III. Experimental results are presented in section IV. Concluding remarks are given in section V.

## II. FACE RECOGNITION

The objective of the proposed work it to study the use of edge and texture orientation as face image features in face image retrieval. The basic architecture of Face recognition system is shown in figure. An improved method based on hybrid approach for face recognition system is proposed in this work.

There are two issues in building a face recognition system.

1. 1. Every face image in the face image data base is to be represented efficiently by extracting significant feature.
2. 2.Relevant face images are to be recognized using
3. similarity measure between query and every face image in
4. the face image data base.

The performance of the proposed face recognition system can be tested by retrieving the desired number of face images

from the database. The advantage recognition rate and recognition time is the main performance measures in the proposed face recognition system. The average recognition rate is known as the average percentage number of images belonging to the same face image as the query face image in the top ‘N’ matches. ‘N’ indicates the number of recognized images.

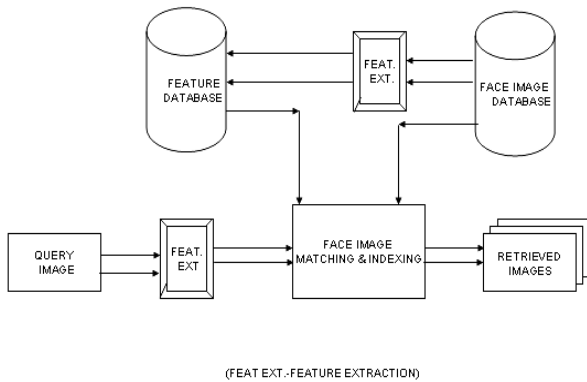


Figure 1.Face recognition system Architecture

### III. PROPOSED ALGORITHM

The basic steps involved in the proposed face recognition algorithm as follows.

1. There are N face images belonging to M persons in the training set;  $N = N_1+N_2+N_3+...N_M$ . Images size is represented as no. of rows and columns ( $A1 \times A2$ ). By using sub-pattern method Each face image is first partitioned into S equally sized, these sub-pattern images are transformed into corresponding column vectors with dimensions of  $d = (A1 \times A2)/S$  using non-overlapping method.

2. In the first step calculate mean value of sub-pattern images. Each of them can be expressed in the form of a d-by-N Column data matrix

$$C_i = \{c_{i1}+c_{i2}+c_{i3}+...c_{iN}\} \text{ with } i = 1, 2, \dots, S$$

Each column of column data matrix must be removed its mean value. After this obtain the vertically centered column data matrix

$$C_{vi} = \{\hat{c}_{i1}+\hat{c}_{i2}+\hat{c}_{i3}+... \hat{c}_{iN}\} \text{ with } i = 1, 2, \dots, S.$$

Similarly

In the second step calculate mean vector  $m_i = 1/N \sum_{j=1}^N C_{ij}$ . Where  $C_{ij}$  denotes the  $i^{\text{th}}$  sub-pattern image of the  $j^{\text{th}}$  face image then obtain centered column data matrix in horizontal direction, i.e.,  $\hat{c}_{ij} = c_{ij} - m_i$ .

3. Each of them can be expressed in the form of a d-by-L eigenvector matrix.

$$P_{Vi} = \{P_{i1}+P_{i2}+P_{i3}+...+P_{iL}\} \text{ with } i = 1, 2, \dots, S.$$

The orthogonal eigenvectors  $P_{i1}, P_{i2}, P_{i3}, \dots, P_{iL}$  corresponding to first L largest positive eigenvalues. The corresponding sub-feature weights based on  $P_{Vi}$  are computed as

$$G_{vi} = P_{Vi}^T C_{vi} = \{G_{i1}+G_{i2}+...+G_{iN}\}, i = 1, 2, \dots, S.$$

Similarly

Horizontally centered column data matrix for first L Largest positive eigenvector..

$$P_{Ab} = \text{diag}(P_{i1}, P_{i2}, \dots, P_{iL}) \text{ with } i = 1, 2, \dots, S.$$

The orthogonal eigenvector  $P_{i1}, P_{i2}, \dots, P_{iL}$  correspond to first L largest positive eigenvalues  $\lambda_{i1} \geq \lambda_{i2} \geq \dots \geq \lambda_{iL}$ .

4. Afterwards, S extracted local sub feature weights of an individual vertically are synthesized into a global feature denoted as

$$G_{Vj} = (G_{1j}^T, G_{2j}^T, \dots, G_{Sj}^T)^T, j = 1, 2, \dots, N.$$

Where  $G_{Vj}$  denotes the  $(L \times S)$ -by-1 global feature vector of the  $j^{\text{th}}$  face image.

5. At final stage necessary to identify a new test image, this image also partitioned into S sub-pattern images. Each of them is represented as  $C_{\text{test } i}$  and its vertically centered is as  $C_{\text{test } vi}$  with  $i = 1, 2, \dots, S$ .

The corresponding sub-pattern image are computed as

$$G_{\text{test } i} = P_{Vi}^T C_{\text{test } vi}$$

Then global feature of the test image is obtained as

$$G_{\text{test } v} = (G_{\text{test } i}^T, G_{\text{test } i}^T, \dots, G_{\text{test } i}^T)^T$$

Finally, the identification of the test image is done by using nearest neighbor classifier with cosine measure, in which the cosine of the angle between the test image and each training image in the database is defined as

$$Z_{Ab} = \sqrt{1/P_{Ab}}$$

Where  $Z_{Ab}$  is the weighted angle

$$R_{vj} = G_{\text{test } v} \cdot G_{vj} \cdot Z_{Ab} / \|G_{\text{test } v}\| \|G_{vj}\|.$$

Where size of  $R_{vj}$  is  $(L \times S)$ -by-1 of the  $j^{\text{th}}$  face image.

$$R_j = R_{vj} + R_{Hj}.$$

### IV. EXPERIMENTAL RESULTS

Recognition performance in terms of average recognition rate and recognition time of the proposed face recognition system is tested by conducting an experiment on hybrid approach face database. A face database [6] test set was constructed by selecting 100 images of 10 individuals, ten images per person. These images of a person used for training and testing. the experimental results are tabulated in Table 1. Since the recognition accuracy of the sub-pattern image, several sizes of sub-pattern images were used in our experiments as shown below:  $56 \times 46 (S=4)$ ,  $28 \times 23 (S=16)$ ,  $14 \times 23 (S=32)$ ,  $7 \times 23 (S=64)$ , and  $4 \times 23 (S=112)$ . Result has been presented in hybrid approach with  $S < 64$ .

**A. Feature selection**

A sample image from face database and by using sub-pattern technique it can be divided by equal parts. Feature of the query image size is (64×1) by using sub-pattern method.

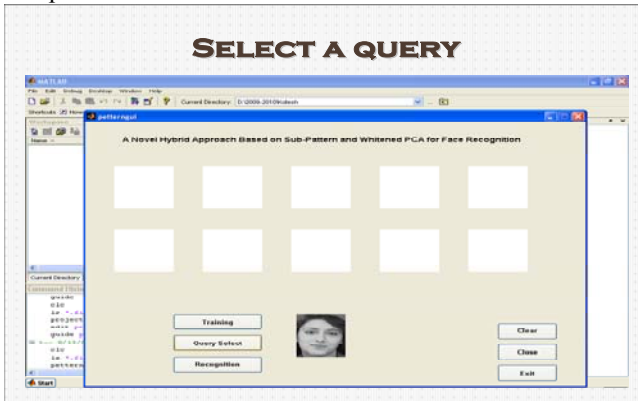


Figure 2. Sample image from face database.

Some of the recognized results when all the 10 images (N=10) in one subject of the image database are recognized are shown in figure 3. From the query image feature is taken based on sub-pattern method. After that in this paper we take only 64 feature of this query image. That may be depends up on the sub-parts of this image(S=16). For each sub-pattern we consider four positive eigenvectors that is largest eigenvector of the sub-part. It is represented as only local feature of the query image. After that combination of all sub-parts local feature it can be represented as global feature of the query image. Comparative performance of all training global feature with this query image finally recognized results images with top left image as query image.



Figure 3. Recognized images

From the experimental results, conclude that: when testing images under varying illumination, sub-pattern method and principal component analysis [8] can significantly improve the recognition accuracy of sub-pattern vertically centered method. Since the vertical centering process centers the data by removing the mean of

each image, it can be used to eliminate the effect of the values. In other words, the property of vertical centering process [9] can be helpful in eliminating the shifted values of original-pixels. Further, the sub-pattern technique can be utilized to encourage the efficiency of the vertical centering process. Therefore, sub-pattern technique is actually useful to vertical centering process of sub-pattern technique. The vertical centering may benefits for the recognition in varying illumination. Now, we have confirmed this possible forecast and strongly increased the efficiency of the vertical centering process by sub-pattern technique in this paper. From the total experimental results, it can also be seen that for expression variant test, sub-pattern technique and Eigen vector can slightly improve weighted angle based approach classifier, the similarity between a test image and training image is defined as

In the weighted angle based approach method cosine measurement

$$R_{vj} = G_{test\ v} \cdot G_{vj} \cdot Z_{Ab} / \| G_{test\ v} \| \| G_{vj} \|$$

Where size of  $R_{vj}$  is (L×S)-by-1 of the  $j^{th}$  face image.

$$R_{Hj} = G_{test\ v} \cdot G_{Hj} / \| G_{test\ v} \| \| G_{Hj} \|$$

Where size of  $R_{Hj}$  is (L×S)-by-1 of the  $j^{th}$  face image.

$$R_j = R_{vj} + R_{Hj}$$

Final feature is represented as in  $R_j$ .

The experimental results of this weighted angle based approach when compared with vertically centered values and horizontally centered values. In which recognition rates of the sub-pattern based approaches were obtained using  $S = 16$ . as can be seen from the results, weighted angle based approach method has best recognition accuracy.

**B. Average recognized rate**

The average recognized rate for the query is measured by counting the number of images from the same category

Methods	Number of top matches				
	1	3	5	7	10
Mean value	100	77.5	71	65	58
Variance	100	58.5	50.5	44.2	36.25
Diagonal(SVD)	100	60	54.5	48.2	42.25
Sub pattern with Weighted angle based Approach (L=Largest four) PROPOSED	100	99.16	96.5	87.85	79.25

which are found in the top ‘N’ matches.

Table 1. Recognized rate on face database.

(1, 3, 5,7,10 are Top ‘N’ recognized images)

From table, we can observe that the recognition rates of five methods. Compared with other process we can get efficient

recognized result, here we are comparing local and global feature [10] of the images. Comparative recognition performance of the proposed face recognition system on the face database using hybrid approach feature is shown in table 1.

In the hybrid approach method cosine measurement

$$R_{vj} = \frac{G_{test} \cdot G_{vj}}{\|G_{test}\| \|G_{vj}\|}$$

Where size of  $R_{vj}$  is  $(L \times S)$ -by-1 of the  $j^{th}$  face image.

$$R_{Hj} = \frac{G_{test} \cdot G_{Hj}}{\|G_{test}\| \|G_{Hj}\|}$$

Where size of  $R_{Hj}$  is  $(L \times S)$ -by-1 of the  $j^{th}$  face image.

$$R_j = R_{vj} + R_{Hj}$$

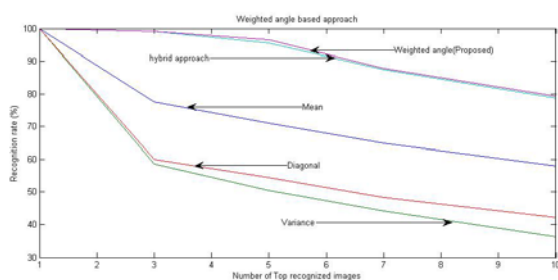


Figure 4. Comparative recognition rates.

Comparative performance in terms of average recognized rate is shown in figure 4 indicates the superiority of the weighted angle based for face recognition system with largest four eigenvectors when compared to largest all positive eigenvector and also be observed over remaining methods in terms of average recognized rate.

### C. Recognized Time

Face recognition system with weighted angle based approach technique for largest four eigenvector recognized time is 51.84 seconds (training time is 51.42 seconds and recognized time is 0.42 seconds), hybrid approach technique for all positive eigenvector recognized time is 52.23 seconds, Diagonal value method in SVD recognized time is 1.65 seconds, variance time is 2.90 seconds and mean value method recognized time is 2.72 seconds.

## V. CONCLUSIONS

Weighted angle based approach for is presented in this paper. Global feature vector is generated and used for face recognition. Horizontal and vertical variations are considered in feature vector. Weighted angle based approach for face recognition gives better performance in terms of average recognized rate and retrieval time compared to existing methods.

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