Weighted Angle Based Approach for Face Recognition

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Abstract. A Face recognition scheme using weighted angle based approach is proposed in this paper. In content based image retrieval, Face recognition system performs fast and accurate detection from database. 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 the existing methods.

Keywords: Sub-pattern, Eigenvectors, Weighted angle**.**

1 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 [1] 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 [2] method (HMM), an image of the whole face is used for pattern recognition [5]. One of the most popular is actually the Eigen faces technology. In the second method, it involves local features and their relationship

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used for classification. In the Third type hybrid method [3] 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 [4], the eigenvector of the co-variance matrix of the set of eigenface images [5], 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 2. Proposed algorithm is discussed in section 3. Experimental results are presented in section 4. Concluding in section 5.

2 Face Recognition Concept

The concept of the proposed work is to study the use of texture orientation as face image features in face based 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.

a) Every face image in the face image data base is to be represented efficiently by extracting significant feature.

b) Relevant face images are to be recognized using similarity measure between query and every face image in 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. Advantage of weighted angle approach recognition rate and recognition time.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.

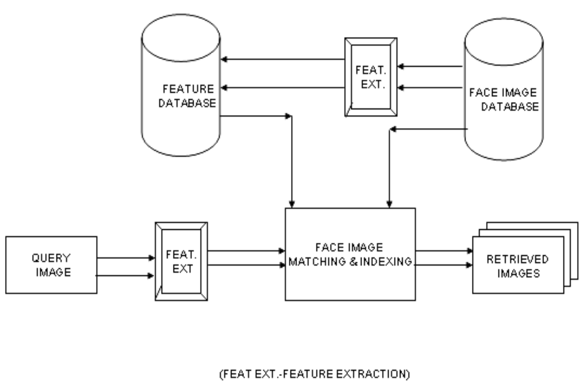

Fig. 1. Face recognition system Architecture

3 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; $N = N_1+N_2+N_3+\ldots N_M$. Images size is represented as no. of rows and columns (A1×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×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

$$C_i = \{c_{i1}+c_{i2}+c_{i3}+\ldots c_{iN}\} \text{ with } i = 1, 2, \ldots\ldots\ldots S \quad (1)$$

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

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

Similarly

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

After this step, obtain the horizontally centered column data matrix

$$C_{Hi} = \{\hat{c}_{i1}+ \hat{c}_{i2}+ \hat{c}_{i3}+\ldots\ldots+ \hat{c}_{iN}\} \text{ with } i = 1, 2, \ldots.S. \quad (3)$$

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

$$P_{Vi} = \{P_{i1}+ P_{i2} +P_{i3}+\ldots\ldots+ P_{iL}\} \text{ with } i = 1,2,\ldots.S. \quad (4)$$

The orthogonal eigenvectors P_{i1},Pi2,Pi3$_{.........}P_{iL}$ corresponding to first L largest positive eigenvalues. The corresponding sub-feature weights based on P_{Vi} are computed as

$$G_{vi} = P_{Vi}^{T} C_{vi} = \{G_{i1}+ G_{i2}+\ldots\ldots+ G_{iN\}, i} = 1,2,\ldots S. \quad (5)$$

Similarly

Horizontally centered column data matrix for first L

Largest positive eigenvector..

$$P_{Hi} = \{ P_{i1,} P_{i2,\ldots\ldots\ldots\ldots} P_{iL}\}_{,} \text{ with } i = 1,2,\ldots\ldots S. \quad (6)$$

$$P_{Ab} = \text{diag}(Pi1,Pi2,\ldots.PiL) \text{ with } I = 1,2,\ldots\ldots S. \quad (7)$$

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

Then, the whitening matrix is computed as

$$P_{Wi} = P_{Hi}\lambda^{-1/2}, i=1,2,\ldots..S. \quad (8)$$

Where $\lambda_I = \text{diag}(\lambda_{i1,} \lambda_{i2,\ldots..} \lambda_{il})$.

Therefore, the sub-pattern weights based are computed as

$$G_{Hi} = P_{Wi}^{T}\ C_{Hi} = \{G_{i1},G_{i2},\ldots.G_{iN}\},\ i = 1,2,\ldots S \tag{9}$$

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

$$G_{Vj} = (G_{1j}^{T},G_{2J}^{T},\ldots\ldots G_{Sj}^{T})^{T},\ j = 1,2,\ \ N. \tag{10}$$

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

Similarly

Av individual horizontal are synthesized into a global feature denoted as

$$G_{Hj} = (G_{1j}^{T},G_{2j}^{T},\ldots.._{GSj}^{T})^{T},\ j = 1,2\ldots\ldots\ldots..N. \tag{11}$$

Where G_{Hj} denotes the (L×S)-by-1 global feature vector of the j^{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 $C_{test\ i}$ and its vertically centered is as $C_{test\ v\ i}$ with i = 1,2…….S.

The corresponding sub-pattern image are computed as

$$G_{test\ i} = P_{Vi}^{T}\,C_{test\ v\ i}$$

Then global feature of the test image is obtained as

$$G_{test\ V} = (G_{test\ i}^{T}\ G_{test\ i}^{T}\ \ldots\ldots.G_{test\ i}^{T})^{T} \tag{12}$$

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

$$Z_{Ab} = \sqrt{1}/P_{Ab} \tag{13}$$

Where Z_{Ab} is the weighted angle

$$Rvj = G_{test\ v}\,.Gvj.\ Z_{Ab}\ /\|\ G_{test\ v}\|\|\ Gvj\|. \tag{14}$$

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

$$R_{Hj} = G_{test\ v}.\ G_{Hj}/\|\ G_{test\ v}\|\|\ G_{Hj}\| \tag{15}$$

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

$$Rj = Rvj + R_{Hj.} \tag{16}$$

4 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: 56×46(S=4), 28×23(S=16), 14×23(S=32), 7×23(S=64), and 4×23(S=112). Result has been presented in hybrid approach with S<64.

4.1 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.

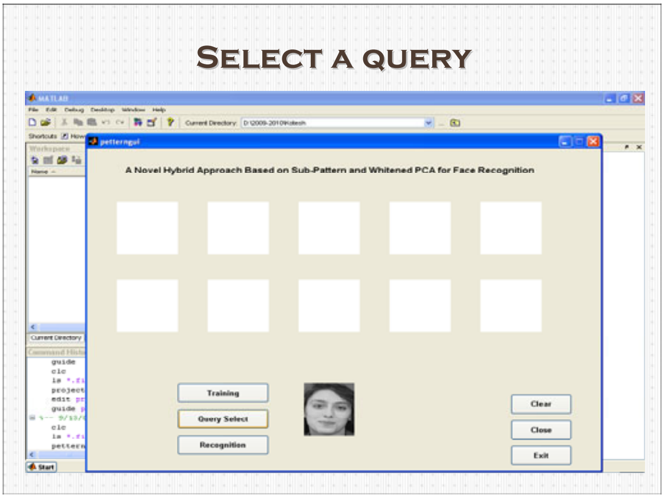

Fig. 2. Sample image from face database

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

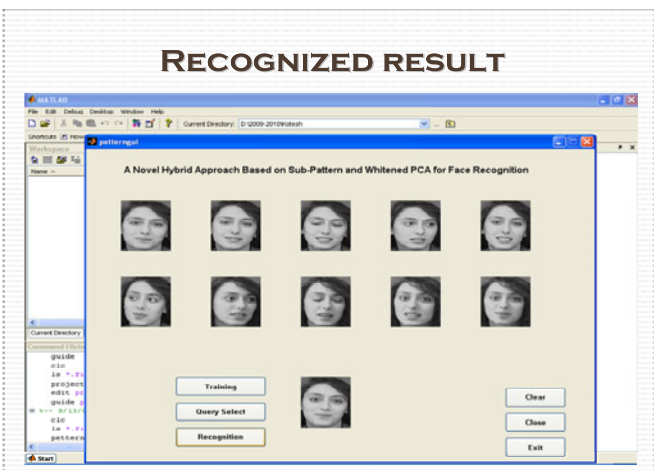

Fig. 3. Recognized images

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.

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

$$Rvj = G_{test\ v} .Gvj.\ Z_{Ab} /\| G_{test\ v}\|\| Gvj\|$$

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

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

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

$$Rj = Rvj + R_{Hj.}$$

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.

4.2 Average Recognized Rate

The average recognized rate for the query is measured by counting the number of images from the same category which are found in the top ‘N’ matches. From below 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.

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

Table 1. Recognized rate on face database

	Number of top matches				
Methods	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
Hybrid Approach	100	99.16	95.5	87.4	78.75
Weighted angle based Approach (L=Largest four) PROPOSED	**100**	**99.16**	**96.5**	**87.85**	**79.25**

In the hybrid approach method cosine measurement

$$Rvj = G_{test\ v} .Gvj/\| G_{test\ v}\|\| Gvj\|$$

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

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

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

$$Rj = Rvj + R_{Hj}.$$

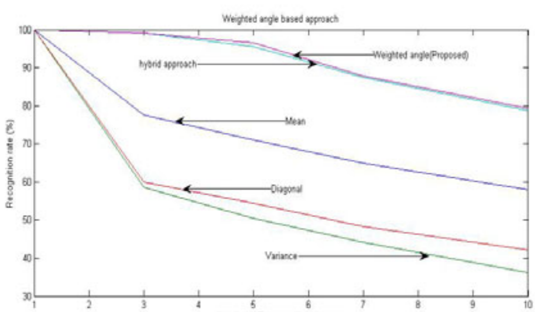

Fig. 4. Comparative recognition rates

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.

4.3 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.

5 Conclusions

Weighted angle based approach for face recognition 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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References

1. Smeulders, A.W.M., Worring, M., Satini, S., Gupta, A., Jain, R.: Content – Based Image Retrieval at the end of the Early Years. IEEE Transactions on Pattern analysis and Machine Intelligence 22(12), 1349–1380 (2000)
2. Gupta, A.: Visual Information Retrieval Technology: A Virage perspective, Virage Image Engine. API Specification (1997)
3. Hsieh, P.-C., Tung, P.-C.: A Novel Hybrid Approach Based On Subpattern Technique and Whitened PCA for Face Recognition. Pattern Recognition 42, 978–984 (2009)
4. Perlibakas, V.: Distance measures for PCA based face recognition. Pattern Recognition Letters 25, 711–724 (2004)
5. Choi, S.I., Kim, C., Choi, C.H.: Shadow compensation in 2D images for face recognition. Pattern Recognition 40, 2118–2125 (2007)
6. Turk, M., Pentland, A.: Eigenfaces for recognition. J. Cognitive Neurosci. 3(1), 71–86 (1991)
7. Yalefacedatabase, `http://cvc.yale.edu/projects/yalefaces/yalefaces.html`

8. Yang, J., Zhang, D., Yang, J.Y.: Is ICA significantly better than PCA for face recognition? In: Proceedings of IEEE International Conference on Computer Vision, vol. 1, pp. 198–203 (2005)
9. Phillips, P.J.: Face recognition: a literature survey. ACM Computing Surveys, 399–458 (2003)
10. Hart, P.E., Stork, D.G., Duda, R.O.: Pattren Classification. John Wiley and Sons, Inc., New York (2001)
11. Chen, S., Zhu, Y.: Subpattern-based principle component analysis. Pattern Recognition 37, 1081–1083 (2004)