Real Time Face Recognition System based Hybrid Method

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Abstract

The rapid development of technologies opens a new research area. Face recognition is one of the effected fields. In this paper an effective hybrid face recognition algorithm is proposed benefiting the wavelet decomposition and Gabor filter for feature extraction and the computation of Eigen faces in classifying the faces. The proposed algorithm proves a good computation time reaching to be less than 0.022 seconds that making it to be a real time algorithm. The proposed algorithm gives a good recognition rate reaching to 100% with a complexity reduction of the Eigen faces computation. For testing Faces94 data base is used.

Keywords: Face Recognition, Eigen faces, mean image, Gabor filter, Complex number, DC components.

I. Introduction

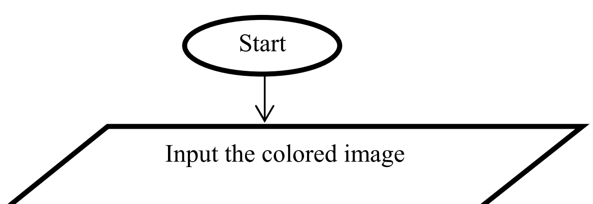
Face recognition is a challenging problematic task in the area of pattern recognition and image processing; it is a challenge mission in terms of hardware that is generating physical implementation and software that is emerging algorithmic solutions [1]. The combination of different classifier method of face recognition produces a somewhat robust method and complicated recognition task that handle the nonlinearity produced by appearance based method [2, 3]. As an example, a method motivated by the human recognition manner that employ both holistic and local features for face recognition providing work for a dual stage holistic by Principle Component Analysis (PCA) and local feature-based recognition by Gabor Wavelet algorithms [4]. In 1991, Turk and Pentland [5] had presented a near real time face recognition system by computing the Eigen faces using PCA algorithm on the trained data set. Their recognition rate is good but sensitive to lighting and orientation variations. Since that time many researchers toke on this technique in their work of developing the face recognition systems and boosting it with preprocessing or on part of its flow. Mazloom and Kasaei [6] used combination of Discrete Wavelet Transform (DWT), PCA and Neural Network. They applied two decomposing level of DWT then came to apply the whole result to PCA and NN. Jain [7] used DWT, PCA and ANN by getting the approximation LL2 as input to PCA-ANN. Haghighat et al [8] had used Gabor filter and PCA. They downed sampling the huge features accomplished by Gabor filter to produce a relatively smaller feature vector used with PCA. Abdulminuim and Ibrahim [9] prove the Gabor DC-based approach in reducing the dimension of the huge features to a small feature vector.

II. Haar Gabor proposed approach

Gabor filters are commonly used in feature extraction methods. Gabor filter is sinusoidal wave modulated by Gaussian function. Gabor filter is based on the frequency, orientation and Gaussian kernel [10]. With varying of these factors a set of Gabor filter banks are generating to be convoluted with the image to generate the corresponding features in a complex numbers form.

The impression of this suggestion is represented by two factors. First, reducing the amounts and dimensions of computation for the set of complex Gabor filters that could be able to reduce the values which are convoluted with the filters. This is decreased the convolution time. And it would be significant to reduce the size of filters. Second, the data come from 2D DWT have more noise error free and less illumination effect that make the feature extracted by Gabor filter more accurate and specific.

The suggested method is implying of applying 2D DWT for one and two decomposition level then Gabor transform is done on LL1 or LL2 sub-band. Two transforms and three orientations for Gabor filters is considered. DC component and magnitude way depended. Figure (1) demonstrates the flow chart of the HGB algorithm that is depended in this work.



The software to implement and test the proposed method is Matlab® 2010a. The database FACES94 is used in testing. The database has images of 153 individuals grouped to male, female and male_staff each has 20 image taken while he/she is spoken with a little variation to positon. The image is colored with resolution of 180×200. In the work the images are converted to grayscale images as a first step.

Referring to the aforementioned in [9] of the computational complexity of Gabor filter is $O(N^2 \times M^2)$ where N is the dimensions of image and M is the dimensions of mask filters with all the proved results we got. One can notice that N is effecting the computation clearly. Traditional ways to reduce the image size is diminished the information in the image. The best way to reduce the size of N in a factor is in keeping the high energy information in this part. Haar DWT in is playing as an efficient way to do this job. By one level decomposition and using LL sub band, N would be $\frac{N}{4}$.

Several experiments are done with different decomposition level and different scales, orientations and filter size with the effectiveness on recognition rate and the number of selected FEFs. Table (1) shows the details of experiments.

Experiments have proved that small size of Gabor filter, gives better results in recognition and this in reality what it is needed to reduce the computational complexity i.e. reduce M in $O(N^2 \times M^2)$. Smaller filter size preserve the computational complexity.

One level of DWT decomposition recognition of 100% is reached but there was a faith that another level would affect well to N which means that N is reduced to $\frac{N}{16}$.

Decreasing scales and orientations means lowering the total number of filter set to reduce the features that will used in computation of Eigen faces.

III. Implementations, experiments and results.

Table (1): Varying in decomposition level, scales, orientation, filter size on recognition rate, and number of selected FEVs of HGB method
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Trail	DWT decomposition level	Scale ranges	Orientation ranges	Filter size	Transmitted data size without the header	Number of selected FEVs	Recognition rate (%)
1	1	3	5	5X5	15	4	100
2	1	2	5	5X5	10	4	80
3	1	3	5	3X3	15	2	100
4	2	2	5	5X5	10	4	95%
5	2	3	5	3X3	15	3	100
6	2	2	5	3X3	10	2	100
7	2	2	4	3X3	8	2	100
8	2	2	3	3X3	6	2	100
9	2	2	2	3X3	4	1	98.7

Different experiments are carried out with different number of training images per individual with good results. While the experiments in table (1) are proceed with training data set of one image per individual, the need to show other results would be inopportune.

By using 2 levels of decomposition, 2 scales and 3 orientations for 3×3 filter, t

he resulting Feature Mean Image FMI is given in figure (1). The reduced 2 Feature Eigen Vectors FEVs is shown in figure (2) while the corresponding to the selected Feature Eigen Faces FEFs is presented in figure (3). The weight of each input image in the training set is shown in figure (4).

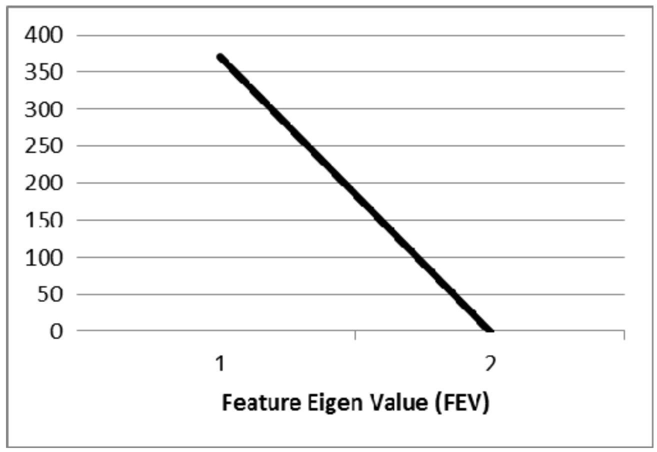


Figure (2): Reduced Feature Eigen Values (FEV) of HGB method.

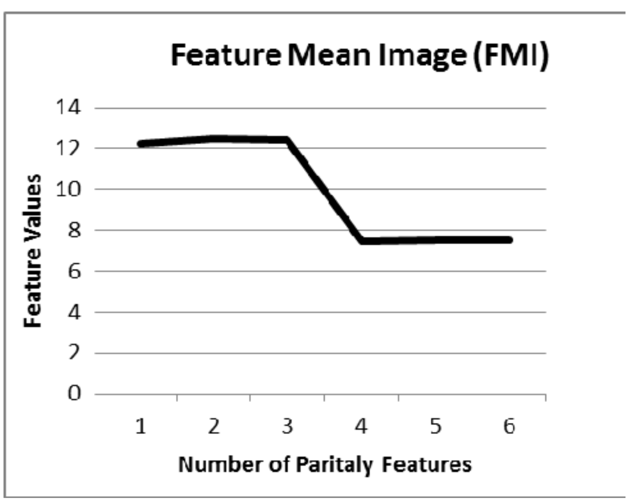
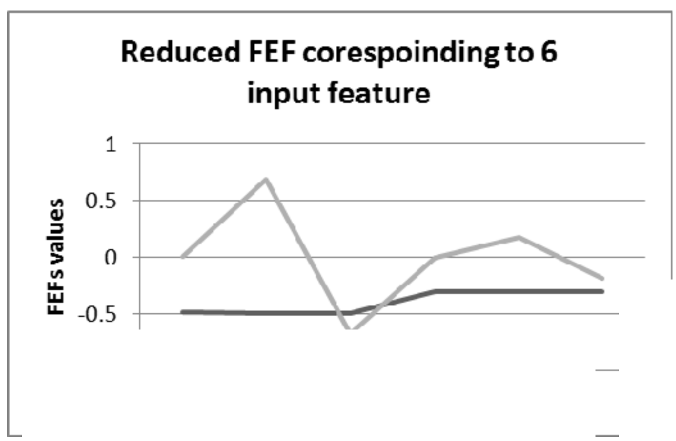


Figure (1): Feature Mean Image (FMI) of HGB method.



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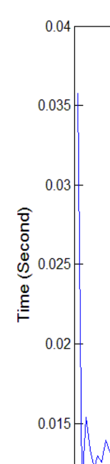

The time consumed by the algorithm is relatively short that it can be suitable to be considered as a soft real time algorithm. The time is perceived in three points of view. The time consumed for partially extract face features of Haar and Gabor filter, the time to compute the feature Eigen faces and the total time to completely extract the features of the face are considered. The results on 210 trails are considered to study the time factor of the algorithm.

The total time is the summation of the above two times. It is computed by:

$$t_{total} = t_{partially\ feature} + t_{FEF}$$
… (1)

Figure (5) shows the first considered time of the partially extracted features. Figure (6) displays the time to compute the FEF and figure (7) demonstrates the total consumed time. And as shown that the time does not exceed 0.022 second which is considered a fast algorithm.

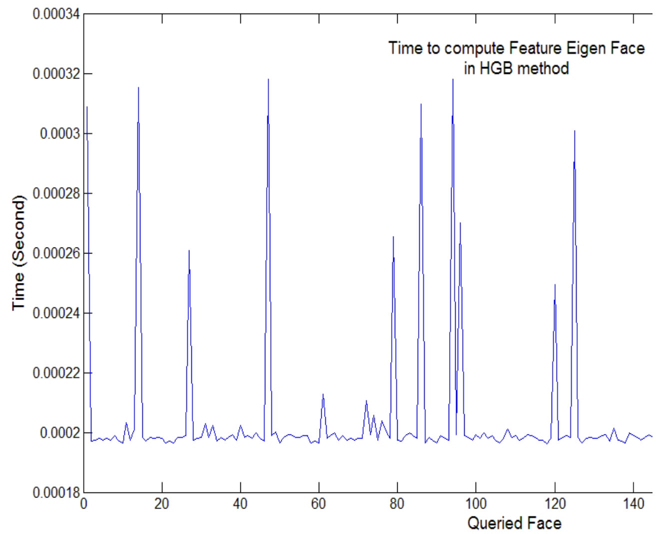

Figure (6): Time to compute the feature Eigen faces in HGB method.

9-a displays an unauthenticated person and figure 9-b explains the distance errors with the FEFs. The discriminative features are clearly classifying the faces from the resulting values.

The tests with only PCA give a resolution of 95% with a recorded larger time to compute the FEFs. That is because of the size of input to the FEF algorithm.

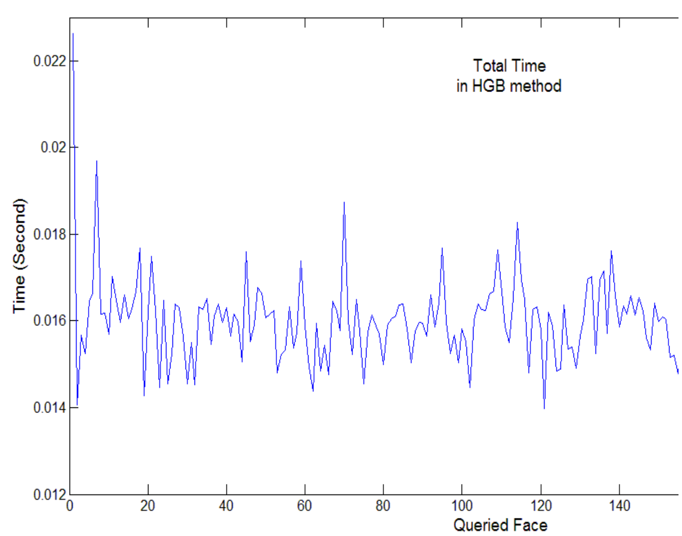

Figure (7): Total Time spends in HGB method.

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Figure (8-a): input tested facial image of authorized individual.

Figure (9-a): input tested facial image of unauthorized individual.

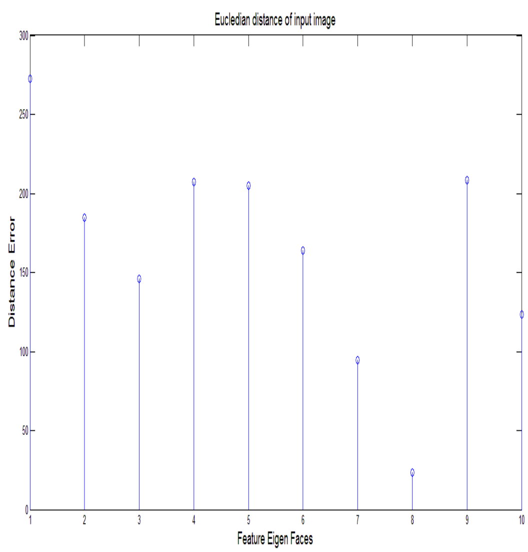

Figure (8-b): Euclidean distance of the testing image in a with FEF manipulated by HGB.

IV. Conclusion.

This paper has presented a face recognition technique suitable to be working in real time environments and based on hybrid method of wavelet, Gabor filter and the computation of Eigen faces. Experiments show that the parameters of Gabor filter of scale, orientation and filter size, as well as, the level of wavelet decomposition are effecting clearly on both the recognition rate and the number of the selected Eigen faces.

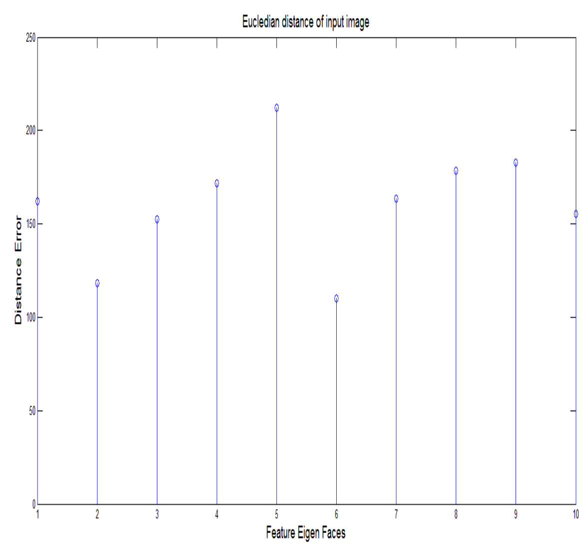

Figure (9-b): Euclidean distance of the testing image in a with FEF manipulated by HGB.

recognition rate reaching to 100%. The choice of Haar wavelet to produce the dimensions of data that are convoluted with the filters is playing a clear role in reducing the amount of computation complexity. Since the system is proved to work in real time environment, it is suitable to work with wireless multimedia sensor network and multimedia communication. Also it can be implemented on low cost hardware.

In future Fisher faces can be computed rather than Eigen faces for more accurate recognition.

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