Hybrid Face Recognition and Classification System for Real Time Environment

Dr.Matheel E. Abdulmunem Department of Computer Science University of Technology, Baghdad, Iraq.

Fatima B. Ibrahim

Department of Information and Communication Engineering Al-Khawarizmy College of Engineering, University of Baghdad, Baghdad, Iraq.

Abstract- Face recognition has been an important and active research field because it offers many applications. A real time face recognition algorithm is proposed in this paper based on the use of Haar wavelet decomposition and the principle of Principle Component Analysis (PCA). The aim of this paper is to reduce the algorithm complexity to achieve the time requirement of real time. To get better recognition rate, feature normalization method is proposed based on the computation of mean and standard deviation for the partially feature extracted. Also the faces are classified using the proposed MCF algorithm. The system accuracy is reaches to 100% with time consumed about 0.03 second.

Keywords - Face Recognition, Eigen faces, Haar wavelet, Real time.

I. INTRODUCTION

The first generation of biometric systems was developed over the last decades. These systems can be found in applications of a wide range of civilian and commercial systems. The second generation of biometric systems can emerge in potentially new biometric feature added value from soft biometric and effective use of multiple biometric features. With the development of smart sensing technologies a wide range of applications and technologies have been appeared and come in the area of research [1]. Face observation is a significant part of the skills of human perception system and is a routine task for humans, whereas construction an analogous computer system is yet an outstanding research area. The earliest work on face recognition can be mapped out back at least to the early 1950s [2].

A face recognition system may require accomplishment of identification and verification or both of them depending on the application requirements and aims. Identification is a multi-class task where the input is recognized to be known or unknown then assigned to a specific class. Verification is easier, it is a two-class task where the input is recognized to be known or unknown only [3, 4]. In face recognition, the facial image is representing in a feature vector obtained from several methods by one or more levels of extraction. Feature vectors should have main aspects. The most important one is that it should give a uniqueness view for each face. What makes other image of the same face near that vector and far away from other faces. These vectors are used to be matched with the data base to compute the similarity of the face with the database [5].

Turk and Pentland [6] in 1991 technologically, had incubated a near real time face recognition system by computing the Eigen face of the trained dataset images depending on the Principle Component Analysis (PCA). In 2011 Georgescu [7] suggested a real time face recognition system. Face detection was done by three stages (integral image which based on Haar like representation and constructed a classifier by AdaBoost learning algorithm which combine a collection of weak classifiers to build a strong classifier but this work has also selected the features and finally an implementation to a cascade of adjusted and trained classifiers were used to improve the system requirement of reducing the false negative) and for recognition the computation of Eigen faces based Principle Component Analysis (PCA) was used. In 2013 Jain and Bhati [8] suggested a face recognition algorithm based on neural network and PCA with DWT reduction they achieve accuracy of 81%.

II. PROPOSED ALGORITHM

Discrete Wavelet Transform (DWT) has a good indication in both feature extraction and compression. Applying 2D DWT on image breaks it down into four sub-bands which are LL corresponding the effectiveness of applying low pass filter twice on this region, HL corresponding the effectiveness of applying high pass filter followed by low pass filter on this region, LH corresponding the effectiveness of applying low pass filter twice on this region, the corresponding the effectiveness of applying low pass filter followed by high pass filter on this region and HH corresponding the effectiveness of applying high pass filter twice on this region.

HL, LH, HH sub-bands are carrying the details of the information of the frequencies. LL sub-band is carrying the approximation information of the frequencies that represent the most useful information for both feature extraction and compression fields. It is useful to apply second, third and another level of decomposing on the LL sub-band. The suggested method has been supposed to compress the face image up to 5 level decomposition using discrete Haar wavelet transform.

This suggestion has been well-thought-out to explain the aspect of Haar wavelet transform of simple computation and fast calculation. Also memory efficient aspect of needless temporary array in calculation is a good working factor. Simple addition and subtraction are enough to perform haar wavelet transform without the need for the convolution process.

Then these partially features obtained are normalized by a method depends on the computation of the Mean (μ) and the standard Deviation (std) (σ) before applying Eigen faces algorithm. Its work is similar to the work of standard min-max normalization but with respecting to the statistical features of the set of data. This method aims to reduce the error that comes from the original face images due to its lighting and brightness conditions.

There is an assumption to estimably determined mean and std for the whole data set, which are used with the sample mean and sample std to compute the normalized sample.

With this method, the accuracy of recognition is superior clearly. The features of the same class (person) are appeared to be more correlated to each other when applying OMOS method. This correlation supports Eigen Faces algorithm, as it depends on analyzing the variances of different features. Algorithm (1) is explained the suggested OMOS transform.

 $\frac{Algorithm (1):}{nput: X vector to be normalized, est estimated standard deviation value,$ em estimated mean value.Output: X_{in} normalized vector.BeginStep1: compute m mean value by: $<math>m = \sum_{i=1}^{n} X_i / n$ Step2: compute st standard deviation value by: $st = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (X_i - m)^2}$ Step3: normalize the vector X where i=1..n, by: $n_{n_i} = \frac{(X_i - m)es1}{st + sm}$ End.

After recognition, a face classification algorithm is suggested inspiriting by the nearest neighbor approach as a classification method and K-mean method as a clustering method that computing the mean value to the feature Eigen faces for each individual to represent the mean of the class. Algorithm (2) has been demonstrated the complete steps of classification.

Algorithm (2): Mean Classification Face (MCF) algorithm.

Input: omg_weight weight of each feature face, N total number of training images for all individuals, M number of samples per individual. Output: Classes of faces obtained from training dataset representing by MC matrix. Begin **Step1:** For initial i = 1 to (N/M) do step 2 - 7 **Step2:** initialize tepm = M*i **Step3:** for initial j = 0 to M-1 repeat **Step4:** col (j)= temp -j; Step5: go to step 3. Step 6: compute the elements of MC by $\sum_{j=1}^{\hat{M}} \sum_{k} omg_{weight}(\underline{k,col}(j))$ MC(i) =М where k is the number of selected FEFs per input Step 7: go to step 1 End.

III. EXPERIMENT AND RESULT

Matlab® 2010a is used for testing the system based on FACES94 database. FACES94 database contains facial images of 153 person's classified as male, female and male_staff. For each person 20 images are taken in the time of that he/she is spoken and make some slight difference to position. Images are color images of resolution 180×200 . As a first step in work grayscale images are obtained from these colored images.

The selection of Haar is linked to its simplicity and speed. These Haar properties' make it suitable to implement on low computational and real time systems. The low computational method to reduce computation of Eigen faces. The reduction has reached to 88%. Figure (1) shows the reduction curve. The reduction of data is near to exponential decrease using the LL sub-band decomposition in each step.



Figure 1. Reduction transmited data size in HB method.

The method c thm which it is array of two dimension. The reduction of array is done by Haar wavelet transform gradually so the computations of feature Eigen faces and feature Eigen values have been decreased meaningfully level by level, the size of the original facial image is 200×180 that need to compute Eigen value and Eigen vector for them which is it high computational complexity.by our approach of reduction the size of the input data to 7×6 input data by five level of Haar wavelet decomposition the computation complexity is reduced significantly.

Also the reduction has an effect on the selected feature Eigen values number and the stored feature database when all the factors are minimized. The recognition rate is improved also level by level. Although, recognition rate reaches to 100% from the third level of decomposition but the computation complexity decreased clearly by another levels of decomposition. Table (1) shows this information.

DWT level	Processed data size	Number of selected FEVs	Recognition rate
Original Image	36000	99	98%
1 level DWT decomposition	9000	99	98.8%
2 level DWT decomposition	2250	99	98.8%
3 level DWT decomposition	575	99	100%
4 level DWT decomposition	156	99	100%
5 level DWT decomposition	42	41	100%

Table 1- The effect of reducing input features for FEF algorithm over thenumber of selected FEVs in HB method.

For 5 level of DWT decomposition, the feature mean image values have been presented in figure (1) and the reduced feature Eigen faces corresponding for 41 feature Eigen values have been presented in figure (3). Figure (4) shows the values of the feature Eigen vectors. It seems that the feature Eigen values are decreased very fast which means that the selecting smaller number of values to represent the feature face space is reasonable. The weight of each training image in the training set in the feature face space is represented in figure (5).

A number of sets for both training and testing are used to test the method. Each one contains different number of facial images for each individual. Minimizing the number of images is affecting minimization number of feature Eigen faces which reduce the size of the feature database obviously. Table (2) describes the details of reduction when each feature Eigen face with corresponding feature Eigen value less than one is discarded.



Figure 2. Feature Mean Image (FMI) of 5 levels DWT decomposition in HB method.





Figure 4. Reduced FEVs for 5levels DWT decomposition in HB method.



Table 2- Recognition rate with FEFs number per different number of trained images in HB method.

Number of images used in training (per individual)	Number of images used in testing (per individual)	Number of FEFs	Recognition rate (%)
1	12	9	100
2	12	11	100
5	12	41	100
10	10	41	100

The recognition rate without applying any normalization transform is 98%. After applying the partially feature extracted by Haar wavelet transform to the proposed OMOD transform the recognition ups to 100%.

OMOS normalization is attempting to normalize the distribution of the whole data to a desired estimated mean and desired estimated standard deviation. Figure (6) shows that the set of partially feature vector before and after applying to OMOS normalization with the HB method. As seen from the figure (6), that the effect appears on the whole set to be in smaller range keeping the value of each vector separated from each other.



The faces have been classified to a number of classes equal to the number of individuals in the training dataset using the suggested MCF algorithm. Experiments have been founded to show efficient results of 100% right classification. Distance error of each individual to the center of class is presented in figure (7). A threshold value is used to compare the distance with each center of class to decide whether the queried face belongs to class or not. The classification of authenticated faces to the corresponding class has been shown in figure (8).



Figure 7. Distance error of each queried face to the center of classes.





Figure 6. OMOS normalization on features of HB method.

The time consumed by the algorithms is relatively short that they can be suitable to be considered as a soft real time algorithms. The time is perceived in three points of view. The time consumed in sensor nodes to partially extract face features, 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 algorithms. The total time is the summation of the above two times. It is computed by:

 $t_{total} = t_{partially feature} + t_{FEF} \qquad \dots (1)$ In figure (9) the partially feature extraction time ($t_{partially feature}$) is shown for HB proposed method. The time to compute the feature Eigen faces is shown in figure (10) while the total time total time for the method which is the summation of the two previous times is shown in figure (11) that is in a range 0.025 second. This time is acceptable in real time systems as a real time face recognition system.





method.

Figure 10. Time to compute the feature Eigen faces in HB method.



Figure 11. Total Time spends in HB method.

IV.CONCLUSION

This paper has presented a face recognition method working on real time environment. It is depending on hybrid method of DWT and PCA principles to both recognition and compression ideas. Using Haar wavelet transform is improving the recognition accuracy. Also the proposed OMOD normalization transform plays a significant role in improving the accuracy of the recognition to reaches to 100%. The face classification of the system is approved by its simplicity, high accuracy and high speed to be used in real time system.

The high speed, good accuracy of the system makes it work in addition to real time, to be suitable for wireless multimedia sensor network applications and the low cost hardware implementation.

The method can be executed with Fisher faces as a future work for more accurate recognition.

REFERENCE

- [1] A. Jain, and A. Kumar, "*Biometrics of Next Generation: An Overview*", Second Generation Biometrics (E. Mordini and D. Tzovaras, Eds.), Springer, 2010.
- [2] W. Zhao, R. Chellappa, P. Phillips, A. Rosenfeld, "Face Recognition: A Literature Survey", ACM Computing Surveys, Vol. 35, No. 4, pp. 399–458, December 2003.
- [3] A. Samani, "Automatic Face Recognition using stereo images", PhD thesis, University of Sheffield, Sheffield, UK. 2006.
- [4] A. Joshi, A. Deshpande, "*Review of Face Recognition Techniques*", International Journal of Advanced in Computer Science and Software Engineering, 5(1). pp: 71-75, 2015.
- [5] S. Nikan, "Human Face Recognition under Degraded Conditions", PhD thesis, Department of Electrical and Computer Engineering, University of Windsor, Windsor, Ontario, Canada, 2014.
- [6] M. Turk and A. Pentland, "Eigenfaces for recognition", Journal of Cognitive Neuroscience, 3(1), pp:71-86, 1991.
- [7] D. Georgescu, "Real-Time Face Recognition System Using Eigenfaces", Journal of Mobile, Embedded and Distributed Systems, vol. III, no. 4, pp: 193-204, 2011.
- [8] S. Jain and D. Bhati," "Face Recognition Using ANN with Reduce Feature by PCA in Wavelet Domain", International Journal of Scientific Engineering and Technology, 2(6), pp: 595-599, 2013.

International Journal of Innovations in Engineering and Technology (IJIET)