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Human Identification via Face Recognition: Comparative Study

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Abstract:*Biometric recognition becomes an attractive issue of processing, and have a vast amount of real applications.According to wide spread of Internet and the new aspect of Internet of things, millions of human characteristics are flying around the world. So the security and identification become a big challenge and most of the individual needs to apply secure system to save their information. Face recognition is a narrow field of biometric recognition but there are vast amount of works and projects concerned this field. These works used various technique to reach high accuracy of recognition. The big challenge of face recognition is how to improve the recognition rate according to the implemented system. The main aim of this approach is concern with the scientific survey of the last two years to generate a simple comparative study of techniques, methods, challenges and benefits of applying these approaches.Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) are measured for all the tested methods 2D-WHT, 2D-DCT, 2D-DWT, 2D-FFT and M-2D-DWT in which the results obtained from M-2D-DWT gives better values of MSE and PSNR.*
Keywords*: Biometrics; Face Recognition; Human Identification; Security.*

I. Introduction

Now adays human identification via face recognition methods are well known issues and have a wide range of applications [1],[2].Face recognition is an attractive filed that combining of image processing, statistical measures, pattern recognition and computer vision and other related fields [3],[4],[5].Different methods of face recognition are designed and implemented such as discrete wavelet transform [6], Curvelet Transform [7], discrete cosine transform [8], principal component analysis [9], independent component analysis [10].Face recognition is an important field of Image processing, and it play an important part of security field [11],[12],[13].Face image representation using different techniques are applied [14],[15].Image Fusion methods for classification and extraction are used to reconstruct the image [16],[17],[18].Fusion technique can be applied for images and videos [19],[20].Quality improving of image is a good issue and it is required to reduce the error as possible and reaching high accuracy [21],[22],[23].Face recognition and enhancement are implemented via different methods [24],[25].Image watermarking leads to security aspect of face identification [26],[27],[28].After this brief introduction we can say that there are many techniques (DWT, DFT, DCT, PCA, SVM …etc.) used for face recognition and the accuracy of these technique depends of many factors such as type of data set, focusing, lighting, resolution, … etc. This work will concentrated on the well-known techniques, in addition some focusing goes to the benefits of these techniques.

II. Literature Review

Big amount of papers are published in this field, and in order to resize our challenge, we will concentrated in this section about the paper published in the last two years.Li Li, JianqiangGaob, HongweiGea (2016) investigated a semi-discrete decomposition method to solve sample imaging problems. Firstly, applying semi-discrete decomposition on original image and its translation via the training set. Next, applying scatter matrices on original image and two approximation images. Then, fined the optimal projection vectors via applying the proposed algorithm.In addition, applying the final classification usingthe closest neighbor classifier. The performance of the proposed method is evaluated on the basis of ORL, Yale and FERET data. The column rotation is implemented to perform the recognition rate applied via experimental test [29].

Hongjun Li, Ching Y. Suen (2016), considered the problem of recognizing the human face from frontal views with variable illumination and occlusion and concealment. They presented an efficient approach face recognition algorithm using extracting dynamic images. Parts of images are used to represent the typical discriminative components that are implemented to classify face images. The experimental results achieved highaccuracy, robustness and speed [30].Biao Leng et al. (2016), proposeda new method to generate reasonable virtual samplesin order to prevent imbalance in classification operation. This method developed boost approach andused face analysis based on Joint Bayesian. This approach achieve an effective experimental results for feature extraction using conventional neural networks [31].

Daniel B. Elbich and K. Suzanne Scherf (2016), implemented the individual differences in brain-behavior according to face recognition system for both core and extended regions. Hybrid measures of behavioral and neural are applied to assessbrain behavior relations. This approach measures and evaluateface and object recognition behaviorfor each region, in addition to the global activation of regions. An effective results are obtained via applying this approach [32].

ShonalChaudhry and Rohitash Chandra (2016),introduced a mobile face detection and recognition approach when the data is acquisition from mobile source. This approach is applied using convolutional neural networks. A video database is created via capturing videos from camera of mobile that faced with many problems via the application. A good results are obtained via applying for daylight and artificial lighting conditions while the other conditions are not acceptable. This approach can be applied for other devices such as smartphones and wearable devices [33].

Xiao Dong (2017), designed face recognition approach based on collaborative representation techniques. This approach is applied via two stage learning methodof face recognition. Thecollaborative coefficients are obtained firstly using unlabeled samples to construct the labeled samples. In order to label all samples in the database, this process is repeated until the operation is completed. The obtained results indicated that this approach is an effective in face recognition [34].

G. Besson (2017), explained the comparison between three approaches of face recognition. These methods are face recognition via face familiarity, superordinate face recognitionand target face person.This approach is implemented for 27 individuals. The approach applied via recent speed and accuracy boosting procedure in order to use their fastest strategy. The high speed is achieved in this approach via applying face recognition for finding a specific person in a crowd location, this lead only a quarter of a second [35].

Q. Wang et al. (2017),optimizedthe ability of composite filters for noise reduction. This approach extract the features and boundaries of the training faces. The composite correlation filter that applied here have a simple implementation approach and does not have any mathematical complexity. A simulation test is applied to ensurethe effectiveness and feasibility of the system. The true positive and false positive rates are measured in this system in an efficient way [36].

Hengmin Zhang et al. (2017), described an efficient approach of robust face recognition. This paper focusing on that the existing face recognition and classification methods concentrated on characterize the representation error.This approach is implemented using nuclear norm to describe the low- rank structural information, on the other hand this may leads to suboptimal solution. This approach leads to an optimal results [37].C-H.Yoo et al. (2017), improved an effective feature extraction method for classifying images. This method realizeand improve the ability for face recognition. This approach is implemented via the partition of thelocal binary pattern into bit planes that specified the face image direction. Then complaining all bit planes to generate the feature vector. The experimental results showed that this method achieve high performance compared with the existing methods [38].

III. Methodology

3.1 Adapted Image Data

In order to be fair for the existing method for human identification via face recognition, we apply each approach on the same set of data.In order to reach the identical case of realization, The Database of Faces that used here is "The ORL Database of Faces" that have 400 faces of 10 different situations for 40 persons. The image size of this database is 92*112 pixels. So the first step to adapt these image into Matlab package, these images are resized into 128*128 pixels to be adapted for fast transforms as shown in figure 1.

Figure 1 resized images into 128*128 pixels

3.2 Implemented Approach

Matlab environment is used to implement various techniques of face recognition. It is impossible to cover all techniques used in this field. So we will concentrated on the well-known techniques, and which have a wide range of applications. Five methods (D-WHT, 2D-DCT, 2D-DWT, 2D-FFT and M-2D-DWT) are explained below.

Two Dimensional Fast Fourier Transform (2D-FFT) that is the fast version of 2D-DFT. The application of this technique on images leads to real part an imaginary part. This technique can be implemented via direct convolution in time domain or indirect convolution in frequency domain. There are many types of FFT and these types depends of the radix of the input data and the most important types are FFT radix2 (base 2) and FFT radix4 (base 4). This technique have a wide range of applications in image processing including face recognition.

Walsh Hadmard Transform (2D-WHT) The fast Walsh-Hadamardtranform algorithm is similar to the Cooley-Tukey algorithm used for the FFT. Both use a butterfly structure to determine the transform coefficients.

Two Dimensional Discrete Cosine Transform (2D-DCT) is an interested technique used for many purposes including face recognition. The output of 2D-DCT (when applied to input image) is only real part. In 2DDCT, the input image is divided into 8-by-8 or 16-by-16 blocks, and the two-dimensional DCT is computed for each block. The DCT coefficients are then quantized, coded, and transmitted.

Two Dimensional Discrete Wavelet Transform (2D-DWT) is a very famous technique used for face recognition. There are various types of masks or families are used to implement 2D-DWT. These masks are Harr, Daubechies, Morlet, Meyer, Mallat … etc. All these masks have the similar procedure for implementation bus they have various weights. The architecture of this technique depends on siplitting the output into four main components. The low-low (LL) component are generated via applying low pass filter on rows of the input image to get low band then apply low pass filter on columns of the output of low band to get LL component. The low-high (LH) component are generated via applying low pass filter on rows of the input image to get low band then apply high pass filter on columns of the output of low band to get LH component. The high-low (HL) component are generated via applying high pass filter on rows of the input image to get low band then apply low pass filter on columns of the output of low band to get HL component. The high-high (HH) component are generated via applying high pass filter on rows of the input image to get high band then apply high pass filter on columns of the output of high band to get HH component.

Modified Two dimensional discrete wavelet transform (M-2D-DWT) is generated via modifying the weighting factor of 2D-DWT. Weighting factor of 2D-DWT can takes different values smaller than one and greater than one. According to the testing of different values of weighting factor, we reach a reasonable value that serve for the comparison.

IV. Results And Analysis

The experiment was started by implementing the methods and functions under Matlab package. These methods and functions are directly related to face recognition. These functions are 2D-WHT, 2D-DCT, 2D-DWT, 2D-FFT and M-2D-DWT. All these functions are applied to the adapted ten images (five male and five female) of size 128*128 pixels. These images start with the number image11m and end with the number 20f.Let the original image is x1 (128*128 pixels) and the retrieved image is x2 (128*128 pixels) then we measured Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) for all the tested methods 2D-WHT, 2D-DCT, 2D-DWT, 2D-FFT and M-2D-DWT as shown in the following two equations.

$$MSE = \sum \quad \sum \frac{(x1-x2)^2}{128*128} \qquad \ldots\ldots\ldots (1)$$

$$PSNR = 10 * log10(\frac{128*128}{MSE}) \qquad \ldots\ldots\ldots (2)$$

Table 1 illustrate MSE values between the original images and the retrieved images, in which the obtained results of the methods 2D-DWT, 2D-FFT and M-2D-DWT are the best results.In addition the MSE obtained from M-2D-DWT is the best one compared with the others. These results also are clear in figure 2 which demonstrates the MSE of both 2D-FFT and M-2D-DWT only because the other methods are out of range. This figure indicates a big difference between 2D-FFT and M-2D-DWT, means M-2D-DWT deals with better performance.

Table 1 MSE for all tested methods

MSE	2D-WHT	2D-DCT	2D-DWT	2D-FFT	M-2D-DWT
Image11m	1.9486e+004	18.0954	1.1058e-021	1.6939e-027	1.9611e-028
Image12m	1.5578e+004	16.6347	1.6768e-021	1.4411e-027	1.2204e-028
Image13m	1.5340e+004	16.8169	1.4509e-021	1.5628e-027	1.4064e-028
Image14m	1.7930e+004	19.2712	6.9203e-022	1.7330e-027	4.8440e-029
Image15m	1.8119e+004	17.4226	1.2278e-021	1.7372e-027	9.2898e-029
Image16f	1.6823e+004	18.7300	7.9118e-022	1.9173e-027	2.2315e-028
Image17f	1.2744e+004	17.9742	1.1694e-021	1.2124e-027	2.1466e-028
Image18f	2.0139e+004	18.1617	1.1754e-021	2.0495e-027	1.3507e-028
Image19f	1.7212e+004	16.1245	1.8352e-021	1.6471e-027	1.1117e-028
Image20f	1.7625e+004	18.0773	1.1458e-021	1.7296e-027	8.7770e-029

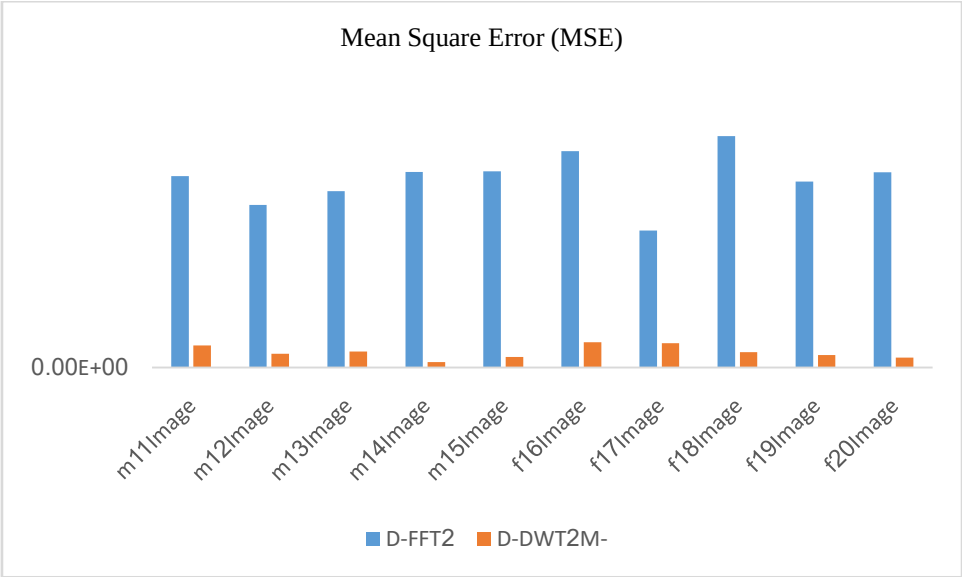

Figure 2 MSE for all tested methods

Table 2 illustrate PSNR values between the original images and the retrieved images of the methods 2D-WHT, 2D-DCT, 2D-DWT, 2D-FFT and M-2D-DWT in which the results obtained from M-2D-DWT are the best results. It is clear that the results obtained from the proposed method M-2D-DWT leads to be better than the other method. In addition these results are also demonstrated in figure 3. From this figure you can see that the three methods 2D-DWT, 2D-FFT and M-2D-DWT demonstrated near values of PSNR, means good results, and the best one mentioned is M-2D-DWT.

Table 2 PSNR for all tested methods

PSNR	2D-WHT	2D-DCT	2D-DWT	2D-FFT	M_2D_DWT
Image11m	5.2335	35.5551	257.6939	315.8419	325.2058
Image12m	6.2057	35.9207	255.8860	316.5439	327.2657
Image13m	6.2725	35.8734	256.5144	316.1918	326.6499
Image14m	5.5950	35.2817	259.7296	315.7427	331.2787
Image15m	5.5496	35.7197	257.2395	315.7322	328.4508
Image16f	5.8718	35.4054	259.1480	315.3040	324.6449
Image17f	7.0778	35.5843	257.4512	317.2944	324.8134
Image18f	5.0904	35.5392	257.4291	315.0142	326.8251
Image19f	5.7725	36.0559	255.4939	315.9635	327.6708
Image20f	5.6694	35.5595	257.5398	315.7514	328.6973

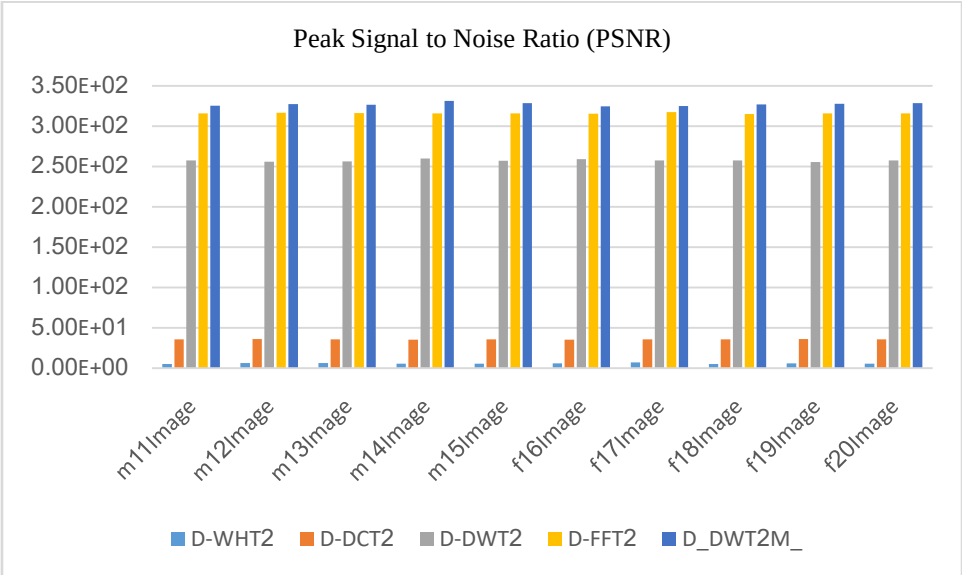

Figure 3 PSNR for all tested methods

V. Conclusions

Face recognition is an important issue that used in human identification and introduced in huge amount of applications. Many face recognition methods (2D-WHT, 2D-DCT, 2D-DWT, 2D-FFT and M-2D-DWT) are implemented to compare their characteristics. To compare the performance of these methods, a database set of images are adapted and resized to fit with the implemented methods. MSE and PSNR are measured to compare the characteristics of the implemented methods for ten adapted tested images. The lower value of MSE means the lower of the error. The higher value of PSNR means the better quality of the compressed image, or reconstructed image. The obtained results indicated a good performance for both MSE and PSNR for the proposed M-2D-DWT method.

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