Face Recognition Enhancement Based on Image File Formats and Wavelet De-noising

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***Abstract*—The aim of this paper is to evaluate Bitmap (BMP) and the Joint Photographic Experts Group (JPEG) face image file formats on the performance of some face recognition techniques. Two databases are proposed and are created from the conversion of Portable Gray Map (PGM) AT&T ORL database to two face databases of BMP and JPG image file formats. In this paper five face recognition techniques, Principles Components Analysis (PCA), Linear Discriminate Analysis (LDA), Kernel PCA (KPCA), Fisher Analysis (FA), and Gabor KPCA are used to compare the performance of the original PGM ORL database with the performance of the proposed BMP and JPG databases on the recognition rate of these techniques. This comparison is done before and after de-noising by Haar wavelet at level 10 of decomposition is applied on the PGM, BMP and JPG databases. Our results show that the proposed BMP and JPG databases have reasonable effect and increased the recognition rate up to (8%) and (3%) before and after de-noising respectively, and the using of de-noised JPG database has good effect and produced high performance when compared with the performance of the same techniques on FERET and ORL databases.**

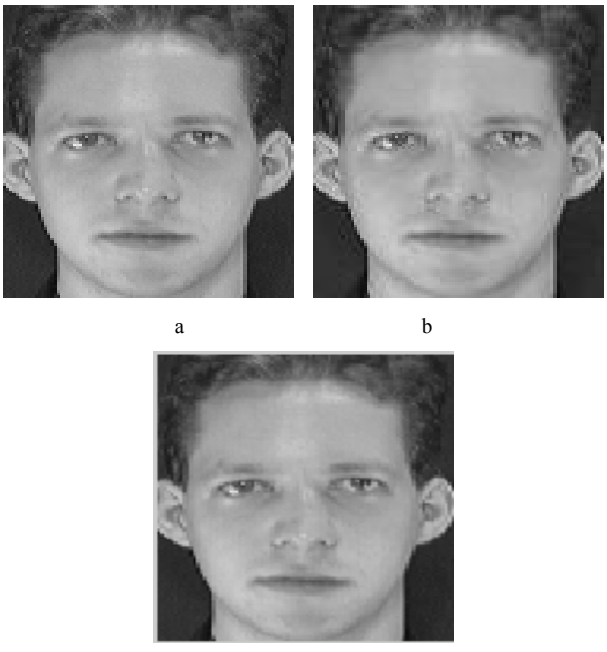
***Index Terms*—Image files formats, Face recognition rate, Haar 10 wavelet, PGM, JPG, BMP.**

I. Introduction

WITH the powerful growing of face recognition applications in the real life, image processing and video processing based face recognition methods are becoming important research topics, and the effects of pose, illumination and facial expressions are occupied currently most studies in face recognition [1], But, very little researches has been done to study the effects of the image formats on the face recognition rate, even though the images are mainly stored and transported in a different formats. Still to still image experimental setups are often researched, but only in Portable Gray Map (PGM) image formats are used to evaluated analyzed the performance of face recognition techniques [2].

All of the files essentially represent the same image but there are big differences, figure 1 shows the same face image with different image formats PGM, JPG and BMP.

The Joint Photographic Experts Group (JPEG) or (JPG) image is the smallest image and is a full 24 bit color image but it is compressed using a lossy compression scheme. This means that the JPG file image is unlike the Red Green Blue (RGB) and Portable Network Graphics (PNG), Tagged Image File Format (TIFF) or (TIF) and Graphics Interchange Format (GIF) files, which are totally equivalent, the JPEG file is different. As a trying to convert an image from RGB to JPEG and back to RGB, this will lead to lose some information related to image quality and can never get it back. The amount of loss depends on the choosing of image compression level and on the nature of the compressed image [3, 4].



a b c

Fig. 1. a) BMP face image, b) JPG face image, c) the original PGM face image.

The aim of our work is to examine the same set of face images in two file formats (BMP, JPG) against the performance of PGM; this is to evaluate the effect of file formats on the face recognition rate. This study is done on AT&T database ORL of 400 face image and implemented on many face recognition techniques. Our goal is to answer two questions, the first one is: Which types of face image file format is better than the PGM format and has a good contribution in enhancing the face recognition rate in some recognition techniques? The second one is: what is the

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effect of wavelet de-noising on the recognition rate of these face image formats? To answer these questions ORL database of PGM format is used to generate two databases of BMP and JPG face images, and then the performance of many face recognition techniques are evaluated when these databases are used before and after de-noising.

II. FACE IMAGE DATABASE

Many developments have been established in face recognition research over the last two decades and many face databases have been collected. These include the Color FERET database [5], SCface - Surveillance Cameras Face database of static images [6], the Yale face database and Yale face database B as gray scale images in GIF format [7], AT&T database of faces formally called ORL database of PGM format [8], Cohn-Kanade AU-Coded Expression Database [9], UK face recognition database all images are in 24 bit RGB-JPEG format, NLPR face database of JPEG format [10], CMU PIE [11] and AR [12]. Detail information about face databases also found by Gross in [13] all these face databases are static images or videos, typically visible RGB or monochromatic, are established under different illuminations, poses, expressions, resolutions, and occlusions.

In this paper we compared our proposed databases with two databases are FERET and AT&T ORL databases, so that in the next subsections, we will give a brief description to these databases.

A. FERET Database

The FERET database contains images of 1,196 individuals, with up to 5 different images picked for each individual. The images are separated into two sets: gallery images and tests images. Gallery images are images with known labels, while test images are matched to gallery images for identification. The database is divided into four categories:

FB: In this database two images were captured to each individual, one after the other. One of the face images has a neutral facial expression, while the other has non neutral expression. One of the face images is set into the gallery file which totally contains 1,196 images and the other is used as a test set which totally has 1,195 images.

Duplicate I: The gallery and the test images are distinct, the face images were taken on the same day or a year apart. The gallery has the same 1,196 images as the FB gallery while the test set has 722 images.

FC: Images in the test set are taken with a different camera and under various lighting conditions than the images in the gallery set. The gallery has the same 1196 images as the FB & Duplicate I galleries, while the test set has 194 images.

Duplicate II: Images in the test set were picked at least 1 year after the images in the gallery. The gallery has 864 images, while the test set has 234 images.

B. AT&T ORL Database

The original Image database consists of a collection of faces taken between April 1992 and April 1994 at the Olivetti Research Laboratory (ORL) in Cambridge, United Kingdom. This collection included 10 different images of 40 distinct subjects. The images were picked at different times with varying luminance and facial expressions “open/closed eyes, smiling/ non-smiling “and facial details “glasses/no-glasses. All the images are taken against a dark homogeneous background and the subjects were in up-right, frontal position with acceptance for some side movement. The image files were in Portable Gray Map (PGM) format, with a size 92x112, 8-bit grey levels with 256 grey levels per pixel. The images are organized in 40 indexed groups (one group for each subject), which have names of the form sA, where A indicates the subject number between 1 and 40. In each of these groups, there are ten different images of the same subject, which have names of the form B.pgm, where B is the image number for that subject between 1 and 10.

III. THE PROPOSED ENHANCEMENT BASED IMAGE FILE FORMATS AND WAVELET DE-NOISING

The most common face image file formats, the most important for face recognition systems. Today many face databases are in different formats PGM, BMP, JPG, GIF and many other formats, these are not the only choices of course, but they are good and reasonable choices for security purposes [14], for this reason we will also give a brief description to the image file formats that used in our paper.

PGM (Portable Gray Map) is a standard bitmap format consisting of a four lines header, the data stored as unsigned char type; consist of 8-bit per pixel with maximum 256 gray scale levels. The structure of a PGM images file consists of four lines header: the first line containing the directory of the image file and identifies the file as PGM. The second line is the comment line. The third line gives information about the number and rows and columns of data stored in the file, and the fourth line identifies maximum gray level contained in the image. The data of PGM image follows the header information and is written in text or binary format as pixel values, this mean the data is in raster order. PGM file images are generally used for displaying and printing purposes and can be opened on many packages that are commercially available like UNIX.

BMP (Bit Map Picture) is a raster graphics image; its rank is suitable for Microsoft Windows Bitmap. This format converts an image pixel bit by bit. It is the only graphics format used where compression actually enlarges the file.

JPEG (Joint Photographic Experts Group) uses lossy compression, but its rank is suitable for higher quality and larger files, or lower quality and smaller files. JPG is used for photo images, and it is not good choice for most graphics or text data. It can be recognized by all Web browsers and it is the best choice today. It is providing only these two formats RGB- 24-bits (8-bit for each color) and Grayscale - 8-bits.

In this paper we examine only BMP and JPG against the PGM, the reason that why we not evaluated the other image file formats like TIFF, GIF and PNG? Because the format of these images are lossless and the recognition rate will not affect (before and after the using of de-noising process) and still stable when these image files are used.

The idea of our work is to examine the feasibility of using

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many types of image file formats in face recognition techniques and test which face file extension is better than the others as a contribution to enhance the recognition rate in some face recognition techniques that used different features extraction such as (PCA, LDA, KPCA, and FA). Our comparisons are done on face databases before and after applying the de-noising process by Haar wavelet and the experiments are implemented on AT&T ORL database.

A. *Image conversion*

The Original ORL database is stored as PGM format, in our work, we convert this extension to other image file formats to generate new databases of BMP, and JPG formats. Figure 2 shows the graphical user interface of converted one of 400 face images of ORL database from PGM image file format to BMP image file format.

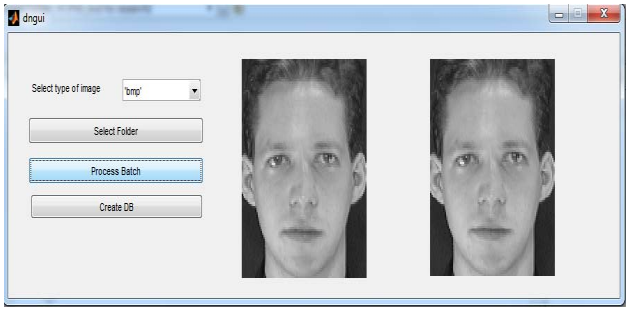

Fig. 2. An example of convert one of 400 face images of ORL database, on the left is the original PGM image and on the right is the BMP image.

B. *Face Recognition Techniques Used*

All databases (the original and the proposed ones) are examined under a statistical feature extraction by using many face recognition techniques PCA, LDA, KPCA and FA as in [15, 16], in addition to Gabor KPCA technique, and passed across many steps including: creating data matrix, creating training images space, calculating mean face from training images, normalization and images dimensionality reduction. The Pretty helpful Development (PhD) face recognition toolbox by struc [17, 18] is used to evaluate our databases, since it contains some of the most popular face recognition techniques. The general steps of face recognition techniques can be summarized as follows:

Step 1: Load images from a database. In our case, the original PGM ORL database and the proposed databases of BMP and JPG are used.

Step 2: Partition data into training and test sets. In our case, the first 3 images of each subject will serve as the training/gallery/target set and the remaining 7 images will serve as test/evaluation/query images.

Step 3: Compute training and test feature vectors using the technique in choice. In our case we use different algorithms for feature extraction (PCA, LDA, KPCA, and FA) and therefore, first compute the subspace using the training data from the ORL database.

Step 4: Compute matching scores between gallery/training/target feature vectors and test/query feature vectors. In our case we use the cosine similarity for computing similarity matrix.

Step 5: Evaluate results.

C. *Image De-noising by Haar Wavelet*

The other proposed part in our work is the image de-noising step, in our work all databases, the original ORL database and the proposed databases are de-noised using Haar wavelet at level 10 of decomposition. The block diagram of the wavelet de-noising process and the feature extraction process is shown in figure (2); we implemented each database on each face recognition technique separately to evaluate the recognition rate and to get the result of recognition.

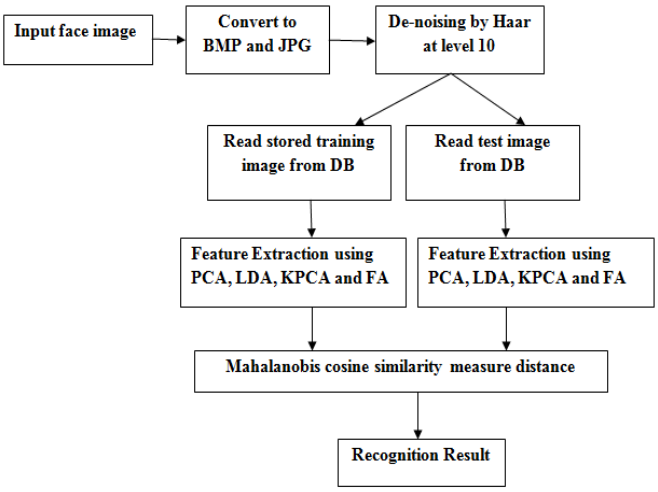

Fig. 3. Block diagram of generating and evaluating our proposed de-noised databases

We can summarize the de-noising process with the following steps that explain the procedure of Haar wavelet de-noising process [19]:

Step1: Load face image database

Step 2: Choose Haar wavelet filter.

Step3: Choose level 10 of decomposition.

Step4: Compute the 2D-DWT of the noisy face image.

Step 5: Threshold the non-LL subbands.

Step 6: Perform the inverse wavelet transform on the original Approximation LL-subband and the modified non-LL subbands.

IV. EXPERIMENTS AND RESULTS

In this work, we produced three experiments, in the first experiment we implemented the ORL database and our proposed databases without de-noising process to get the face recognition rate for each recognition technique as shown in table (1), in the second experiment we implemented Haar wavelet de-noising filter on these databases , and the face recognition rate for each technique after the de-noising process are illustrated in table(2) , finally, in the third experiment we evaluated our database by comparing it with the performance of FERET and ORL databases (JPG,BMP,JPG), when they used with same face recognition techniques and the result are illustrated in table(3).

The result of table (1) shows that the BMP and JPG contributed in raising the recognition rate in all techniques when compared with the PGM database and they nearly have the same performance.

The two proposed databases give recognition rate higher

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than the original PGM ORL database and the recognition rate increased up to (8%,5%,3.5%,5% and (10%-14%)) in PCA, LDA, KPCA ,FA and Gabor KPCA respectively.

TABLE I
COMPARISONS OF RECOGNITION RATES ON SAMPLE OF 400 FACE IMAGES OF ORL DATABASE WITH PGM, BMP AND JPG FORMATS (WITHOUT DE-NOISING)

Face Rec.	.pgm [17,18]	.bmp	.jpg
PCA	66.07%	74.29%	74.29%
LDA	86.07%	91.43%	91.07%
KPCA	49.29%	53.93%	53.57%
KFA	85.71%	88.21%	88.21%
Gabor KPCA	66.67%	76.67%	80.00%

In the second experiment, we implemented Haar wavelet de-noising process at the level 10 of decomposition on all databases (the original and the proposed databases). The result in table (2) shows the recognition rate after the de-noising process is applied on these databases and evaluated with different face recognition techniques. As a result, we found the recognition rate with JPG database is higher than the recognition of the original PGM ORL database and BMP database; this is because the advantage of wavelet over compressed JPG image files.

TABLE II
COMPARISONS OF RECOGNITION RATES ON DE-NOISING ORL DATABASES (PGM, BMP AND JPG) USING HAAR 10 WAVELET

Face Rec.	.pgm	.bmp	.jpg
PCA	66.43%	68.93%	69.29%
LDA	89.29%	91.07	92.14
KPCA	51.07%	52.14%	52.43%
KFA	86.07%	89.29%	89.64%
Gabor KPCA	70.00%	80.00%	83.33%

From the above table, we find that de-noising of JPG face images database produced higher recognition rate than the other two databases with all five recognition techniques, and we found that the using of de-noising process by Haar at level 10 of decomposition raised the recognition rate in the original PGM database also and lightly increased up in range between (0.5% to 3%) more than the one before de-noising in all techniques. In addition, the de-noising process increased the recognition rate for proposed databases to range arrived to 3% more than the original PGM de-noised database for PCA, LDA, KPCA and FA and reached to 13% for Gabor KPCA.

Table (1) and table (2) illustrated that our proposed databases in BMP and JPG formats produced recognition rates higher than that of PGM ORL database before and after Haar 10 de-noising filter was applied on these databases.

In the third experiment, to evaluate the performance of our database, we compared it against two databases: FERET and AT&T ORL databases which are commonly used in many research areas that related to face recognition applications, and two methods are examined represented by PCA with two metrics (the standard PCA with Euclidean distance and PCA with Mahalanobis cosine matrix or Mahcos), and LDA with Machos distance metric.

TABLE III
COMPARISON OF RECOGNITION RATE IN PCA AND LDA OF OUR JPG DATABASE (BEFORE AND AFTER DE-NOISING) AGAINST FERET AND AT&T ORL DATABASES

Database	DB used	Standard PCA	PCA+ Mahcos	LDA + Mahcos
FERET [20][21]	fb	76.67%	64.94%	70.88%
	fc	11.06%	32.99%	41.24%
	Dup 1	33.08%	25.62%	27.70%
	Dup 2	12.81%	27.70%	16.67%
AT&T ORL [17,18]	PGM	77%	66.07%	86.07%
My proposed JPG DB	before	82%	74.29%	91.07%
	after	83.5%	69.29%	92.14%

V. CONCLUSIONS

The intended aim of face recognition systems is to retrieve face images which are very identical and matching to a specific query face image in large faces databases. The retrieved face images can be used for many applications, such as visual surveillance, criminal face verification, extracting specific faces from the web, and photo management.

This is the first work that takes in its consideration the effect of face image file formats on the face recognition rate. We computed the recognition rates of the proposed databases without de-noising and with Haar wavelet de-noising at level 10 of decomposition, and the conclusions can be summarized to:

1.The image file formats have effect in improving the recognition rate of some face recognition techniques, and the de-noising process produced good enhancement in the recognition rate especially with JPG images in some face recognition techniques as in table (3), this is because we exhibit the advantage of wavelet in compressed domain and this lead to give a relative improvement up ≈ 3% in the recognition rate via de-noising as in table (2), and up ≈ 8% with non de-noising JPG database as in table (1).

2. JPG image is the smallest images among other files format, this mean reducing the size of input face image by wavelet de-noising then the image is sent to the process of feature extracting for recognition, this lead to increase the accuracy ratio and to achieve high performance.

3. Image de-noising using Haar wavelet at level 10 of decomposition is easy to implement and only a small amount of work is needed concerning the preprocessing for any type of face images, in addition the use of Haar wavelet over JPG rather than PGM file format has the main reason to enhance the matching distance of face images when compared to the original FERET and PGM ORL database because the flexibility of wavelet de-noising over compressed file images like the JPG file format.

4. Our proposed databases with or without de-noising can be trusty used for face recognition systems in airports, monitoring systems, verifying of criminals in the police office and many different security measures.

5. TIFF, PNG and GIF image file formats produced the same performance when used as face databases and

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implemented on the same recognition techniques, also we found all these formats have recognition rate equal to that of BMP database with and without de-noising, this is because the lossless formats of these images and this is the main reason that we didn't mention these formats in our paper.

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