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Improve Face Recognition Rate Using Different Image Pre-Processing Techniques

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ABSTRACT : *Face recognition become one of the most important and fastest growing area during the last several years and become the most successful application of image analysis and broadly used in security system. It has been a challenging, interesting, and fast growing area in real time applications. The propose method is tested using a benchmark ORL database that contains 400 images of 40 persons. Pre-Processing technique are applied on the ORL database to increase the recognition rate. The best recognition rate is 97.5% when tested using 9 training images and 1 testing image. Increasing image database brightness is efficient and will increase the recognition rate. Resizing images using 0.3 scale is also efficient and will increase the recognition rate. PCA is used for feature extraction and dimension reduction. Euclidean distance is used for matching process.*
Keywords :*Pre-Processing, ORL Database, Face Recognition, Image Cropping, PCA, Euclidean Distance*

I. INTRODUCTION

Face recognition is one of the most interesting and fastest growing biometric areas and it can be applied in many challenging fields. Face recognition is the process of identifying person face from an existing face database. Face recognition can be classified into two mainly types: verification and identification process. Verification is the process of comparing the face image against temples face image whose identify is being claimed. While, Identification will compare the face image against all temples face images in specific face recognition database [1]. Face recognition is used in a wide range of applications because it has high accuracy and safety compared with other kinds of biometrics, does not require physical interaction, and can use any type of camera or images capture device. Recognition process can be simple and easy to identify a person from a huge face database. With face recognition, we can recognize a person just by capturing his/her image [2][9]. In face recognition system, cameras are set up in surveillance locations so that all the objects are captured discretely in real time.

Biometric-based methods become the most promising face recognition option. Biometrics is a user-friendly authentication method that utilizes biological data to identify a person. Instead of certifying people and allowing them access to physical and visual domains based on smart card, passwords, PINs, plastic cards, keys, and tokens, these methods examine the physiological and/or behavior characteristics of a person to verify identify. Biometric-based identify based on physiological characteristics (e.g., face recognition, finger geometry, fingerprints, palm prints, hand veins, hand geometry, ears, voice pattern, iris, and retina) and behavioral traits (e.g., keystroke, dynamics, gait, and signature) [2].

Passwords and PINs can be guessed or stolen and are difficult to remember, Cards, keys, and tokens can be misplaced or duplicated and magnetic cards can be damaged and corrupted, However, biometrics traits cannot be misplaced, forgotten or stolen. Fig 1 shows the most important biometrics types. Face biometric systems have the highest possible collectability and acceptability. These systems use images that are acquired quite easily. In addition, using face images for identification in daily activities such as in passport and national card, is readily accepted by people.

The major reason for weak performance of the system is huge facial variations. The repeated presentation of the same person's face can also cause a difference because of the person's pose relative to the camera, lighting conditions, and expressions. The face may also be obscured by hair, glasses, and jewelry, and facial appearance may be change by makeup. The overall performance of a face recognition system should be able to generate results within an acceptable time [3]. In human-robot interactions, the actual reply time is very important. In addition, it allows computer systems to recognize facial expressions and infer the actual emotions from these expressions.

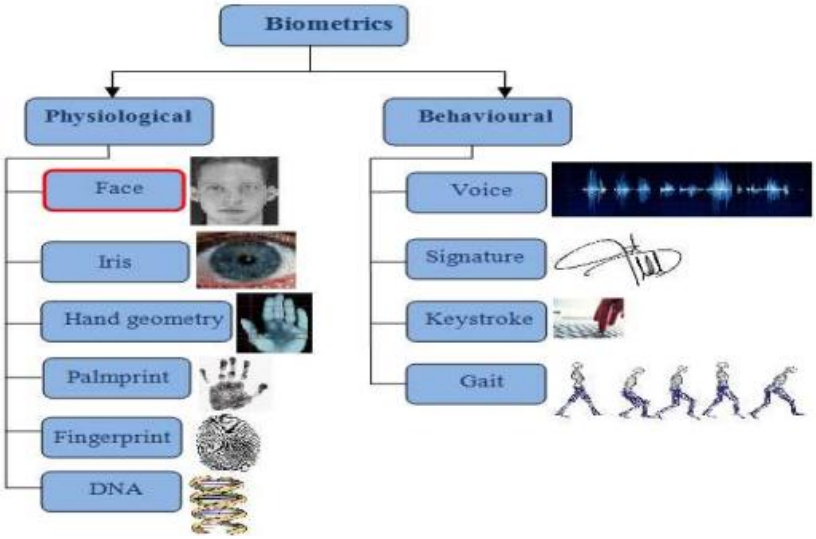


Fig 1: Types of Biometrics.

II. FACE RECOGNITION APPLICATIONS

One reason face recognition has attracted much research attention and sustained development over the past 30 years is its great potential in numerous government and commercial. Most important face recognition applications are listed in table1. In addition to these applications, the underlying techniques of current face recognition technologies are also modified and used for related applications, such as gender classification, expression recognition, and feature recognition and tracking [7][2].

Table 1: Face Recognition Applications.

Areas	**Specific Applications**
Security	Office access, building access control, airports, flight boarding system, email authentication on multimedia workstations, and trading terminals security.
Surveillance	Monitoring and searching for drug offenders and know criminals, power grid surveillance, CCTV control, and portal control.
Criminal Justice System	Post-event analysis and forensics.
Image Database Investigation	Searching image database of licensed drivers, benefit recipient, missing children, immigration checkpoints, national ID, welfare registration, and police bookings.
Human-Computer Interactions	Proactive computing and interactive gaming.
Smart Card Applications	In lieu of maintaining a database of face images, face prints can be stored in a smart card, bar code, or magnetic strip and authenticated by matching the live image with stored template.
Video Indexing	Labeling faces in video.
Civilian Applications	e-booking and e-commerce.
Multimedia Environments with Adaptive Human-Computer Interface	Part of ubiquitous or context-aware systems, behavior monitoring at childcare or senior citizen centers, and recognizing a customer and assessing the customer's needs.

III. IMAGE PRE-PROCESSING

Image preprocessing can extensively increase the trustworthiness of an optical inspection. Numerous filter techniques that further intensify or reduce a particular image information allow easier or much faster evaluation. Users can optimize a camera image with just a few clicks. Image preprocessing decrease processing time and increase the chances of accurate matching [5]. Face images are preprocessed to satisfy the requirements of feature extraction.

3.1 Image Cropping

The selection of specific set of preprocessing steps differs according to the particular application concerned. All the face images used from the database are manually aligned by adjusting the location of the eyes. Therefore, all the faces are rotated initially to set the centers of the eyes on particular pixels. The image region where the face can be found is then cropped and only this region is used in the face recognition process. The face is cropped

from the whole image manually depending on the position of the left and right eyes as well as the mouth [6]. Lastly, all the new images need similar dimensions. Therefore, after cropping the face from the original image, the new images are normalized to a standard size of 64 x 64 pixels as shown in Fig 2.

Fig 2: Image Cropping.

3.2 Image Resize

The images used in the analysis are resized in different scales to determine how various sizes affect the recognition process. Different image sizes carry different information that's why the best image size needs to be examined in details. The purpose of image resizing is to produce a lower data size, which hastens the processing time [6]. The resize scale randomly varies from 0.1 to 0.9 value, which produces different image sizes. Fig 3 shows an example of image resizing with a scale of 0.5. Resizing the image to a small scale can lead to the loss of many important features, especially if the image texture is used during classification. Fig 4 shows an example of the feature lost when the image is seized with a scale of 0.25.

Fig 3: Original Image Resize with Scale 0.5.

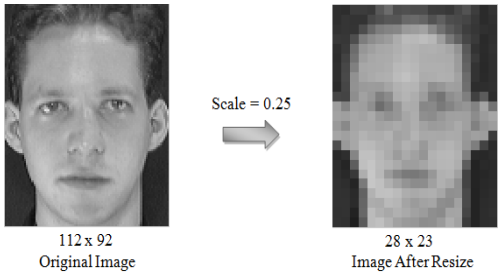


Fig 4: Original Image Resize with Scale 0.25.

3.3 Changing the Brightness

Changing the brightness is one of the easiest pre-processing techniques. Brightness refer to the overall lightness or darkness of the image. To increase brightness, some constant values must be added to each pixel. To decrease the brightness, some constant values must be deducted from each pixel. The value of brightness usually from -255 to +255. Negative values will darker the image and positive values will brighten the image. Fig 5 shows an example of increasing image brightness. Darker or lighter images can be needed in some cases.

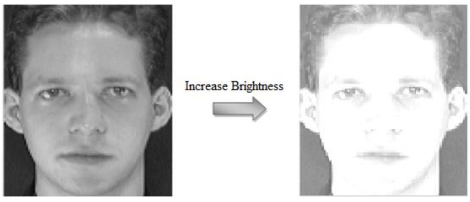


Fig 5: Increase Image Brightness.

IV. FACE RECOGNITION METHODOLOGY

The Proposed technique generally designs face recognition using 2D face images with different variations in pose aging, and expression. The system is tested using the ORL database that contains a total of 400images. Different pre-processing techniques are used, such as image cropping and image resizing. Each technique is applied on the face image to improve image quality. The pre-processing techniques are applied to increase the recognition rates.

Low-dimensional face features extracted from the linear projection technique is used for the recognition process. In this work. PCA is a statistical projection technique used for face recognition. PCA is used for feature extraction and dimensionality reduction, which can solve recognition problems.

Distance classifier is used for the classification. Euclidean distance is used to calculate the difference between two vectors in the feature space. The distance value between the two images measures the similarity of both images. Euclidean distance is used to measure the distances from the probed feature image to the reference feature image in the template. The two images similar when the distance between them is minimal.

4.1 Principal Component Analysis

Principal component analysis (PCA) reduce dimensionality, which can be used to solve recognition and compression problems [6]. PCA is a popular linear technique, and is also known as Eigen space projection, Karhunen and Loeve (KL) transformation, or Hotelling [3]. PCA reduce dimensionality by extracting the Principal components of multidimensional data. PCA can extract the important features, capture the nearly variable data components of samples, and then select numerous significant individuals from all the feature components. Through PCA, an efficient and simple recognition process can be obtained compared with other approaches. Recognitions that use PCA features also perform better in singular variation caser for each person. Raw intensity data are used for recognition and learning without mid-level or low-level processing. PCA is unsupervised and does not require any knowledge about face images. Data compression can also be computed using the subspace of the low-dimensional representation [4] [10]. In face recognition the implementation of face recognition called Eigen face technique.

Eigenface technique steps are as follow:

1.Represent images as column vector.

2. Compute the average mean for the training images as show in the equation below:

$$AverageMean = \frac{1}{M}\sum_{n=1}^{M} TrainImage\ (n) (1)$$

Where M is the total number of training images,

3. Subtract the original image from the average mean as shown in the equation below:

$$S = TrainImage - AverageMean \quad (2)$$

4. Compute the covariance matrix as shown in the equation below:

$$Covariance = \frac{1}{M}\sum_{n=1}^{M} S(n)S^{T}(n) \quad (3)$$

5. Eigenvalues and Eigenvectors need to be calculated.

6. Sort and eliminate Eigenvalues.

7.Project the training samples onto the Eigen faces.

4.2 Euclidean Distance

Euclidean distance is used to classify and obtain the similarity level. It is widely used because it is faster than other classifiers and is simple. Euclidean distance is defined as the straight line distance between two points, which examines the root of square differences between the coordinates of a pair of objects. A minimum Euclidean distance classifier is the most favorable condition for normally distributed classes [11]. Euclidean distance can be represented by the equation below:

$$d(X,Y) = \sqrt{\sum_{i=1}^{M} (X_i + Y_i)} \ (4)$$

4.3 Face Database

The availability of a database that contain a suitable number of representative samples is crucial in any pattern recognition research. Face image data acquisition and database creation have received great attention from

computer researchers in recent years. The results of face recognition research highly depend on the flexibility (availability of moderately large person samples) of the database used.

Face recognition continues to be one of the most popular research areas in computer vision and machine learning, leading researchers to create numerous face databases. However, many of these databases are tailored to the specific needs of the algorithm under development. ORL, FERET, AR Face, MUCT, UMIST, and Yale are some of the important publicly available face databases. ORL database which also known as AT&T will be used in this work. The ORL database contains a total of 400images, which consist of 40 persons (4 females and 36 males) with 10 different images each [12]. Table 2 shows ORL database properties.

Table 2: ORL Database Properties.

Properties	**Description**
No. of subjects	40
No. of images	400
Purpose	This database is primarily used for face recognition
Static / Video	Static
Gray / Color	Gray
Format	.pgm
Resolution	92 x 112
Face Pose	Moderate pose variation (up and down, quarter profile to frontal view)
Facial expression	Three facial expression: natural, smiling, closed eye
Background	Dark homogeneous
Accessories	Glasses

V. RESULT AND DISCUSSION

In this analysis, different number of training and testing images are used to examine the recognition rate performance. Image Pre-processing techniques are applied on the ORL database to increase the recognition rates. Table 3 shows the recognition rate before and after applying any pre-processing techniques. The analysis shows that the recognition rates increase after the images are resized using the 0.3 scale, while brightness is increased by adding 140 to each pixel for all the database images.

Table 3: The Recognition Rate Before and After Image Pre-Processing.

No. of Testing Images	**No. of Training Images**	**Recognition Rate**	**Recognition Rate (Pre-Processing)**
9	1	62.22 %	67.22 %
8	2	71.25 %	75.31 %
7	3	72.86 %	80.71 %
6	4	77.92 %	85 %
5	5	80 %	86 %
4	6	91.25 %	93.13 %
3	7	93.33 %	96.67 %
2	8	95 %	97.5 %
1	9	95 %	97.5 %

5.1Image Cropping Analysis

Some irrelevant parts of the image can be removed to focus on the region of interest of the image. The image sizes are changed after being cropped to 61 x 61 pixels. Fig 6 shows the images before and after cropping. Cropping refers to the removal of the outer parts of an image to improve framing, accentuate subject matter or change aspect ratio. ORL database contain 400 images and there is other database contain more than 400 images. Cropping each image manually is not practical and take time. Using face detection can detect the face and crop each face image to remove unwanted details. Fig 7 shows the recognition rate after image cropping.

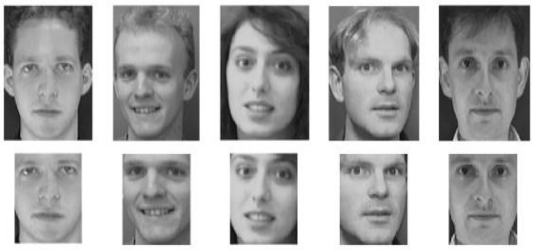


Fig 6: Images After Cropping.

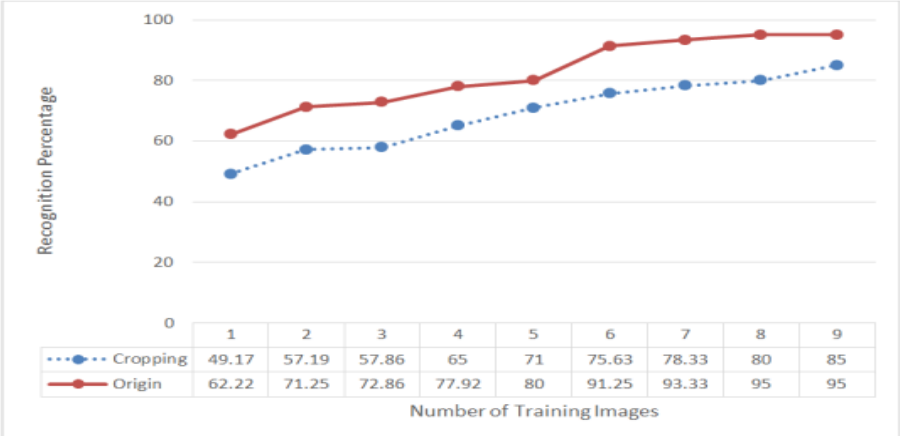


Fig 7: Recognition Rate After Image Cropping.

5.2 Image Resize Analysis

The database images resized in different scales to examine the effects of recognition process. Image resizing hastens the computation when dealing with small sized data. The scale of resizing the image varies from 0.3 to 0.9. When resizing uses the 0.5 scale, the images become 56 x 46 pixels, and when the images are resized using the 0.3 scale, the images become 34 x 28 pixels. Fig 8 shows an example of images resized using the 0.3 scale. Fig 9 shows how the recognition rate increases after the images are resized using the 0.3scale. Resize the image by choosing the right scale value depends on image resolution can be efficient and increase the recognition rate.

Fig 8: Images After Resized by Scale 0.3.

Fig 9: Recognition Rate After Resize with Scale 0.3.

5.3 Change the Brightness Analysis

The difference between the darkest and lightest areas and the blurriness of images can be adjusted. In this analysis, the image brightness increases when 100 or 140 are added to each pixel and the recognition rate is increased. The images are darkened when deducting 100 or 140 from each pixel and the recognition rate is decreased. Fig 10 shows the new images after increasing the brightness by adding 140 to each pixel. Fig 11 shows the new images after decreasing the brightness by deducting 140 from each pixel. Fig 12 shows the recognition rate after increasing and decreasing the brightness. According to the results, increasing the brightness will increase the recognition rate. Decreasing the brightness is not efficient and will decrease the recognition rate.

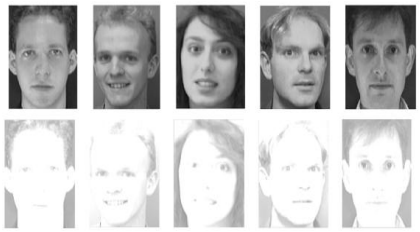
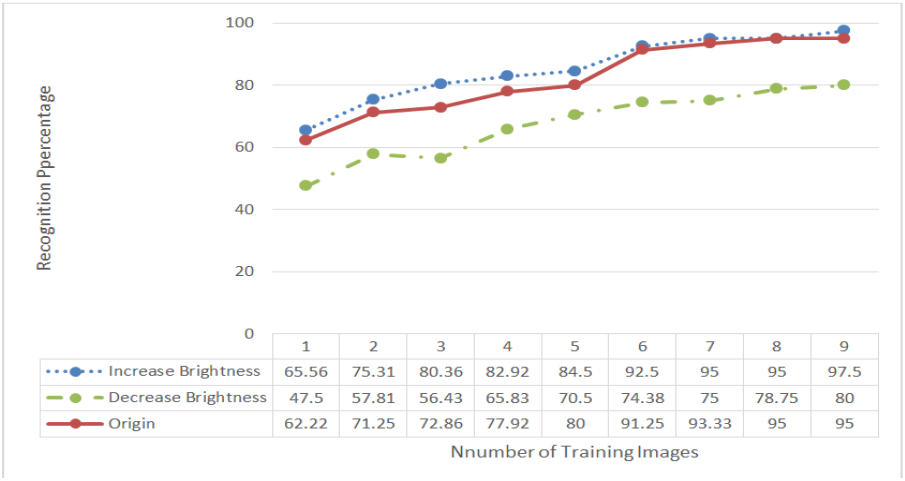


Fig 10: Increase the Brightness by Adding 140 to Each Pixel.

Fig 11: Decrease the Brightness by Subtracting 140 from Each Pixel.



	1	2	3	4	5	6	7	8	9
Increase Brightness	65.56	75.31	80.36	82.92	84.5	92.5	95	95	97.5
Decrease Brightness	47.5	57.81	56.43	65.83	70.5	74.38	75	78.75	80
Origin	62.22	71.25	72.86	77.92	80	91.25	93.33	95	95

Fig 12: Recognition Rate After Increase and Decreasing the Brightness.

VI. CONCLUSION

Face recognition is one of the most fastest growing biometric areas and it can be applied in many fields. According to the experiment conducted on face recognition that using PCA and Euclidean distance, the ORL database is used. Pre-processing techniques are applied on the ORL database to increase the recognition rate. Different number of training and testing images are examined to investigate the performance. Increase the number of training images will increase the recognition rates because of the rich information in the feature space. When the images are resized using 0.3 scale, the size of each image becomes 34 x 28 pixels and the recognition rate increases. When resizing images, the appropriate scale must be carefully selected to avoid losing the face features. Small sized image reduces both feature dimension and computation complexity.

Increasing the brightness by adding 140 to each pixel further increases the recognition rate. Increasing image brightness is efficient and provides significant results. Images are cropped similarly, and the size of the new images become 61 x 61 pixels. Cropping removes all the additional features that are unimportant. Cropping is important for removing the image background because the background effect reduces the discrimination power in the feature space. Increase the brightness by adding 140 to each pixel and at the same time resize the image using 0.3 scale will give the best recognition rates.

REFERENCES

[1]. Bakhshi, Yukti, SukhvirKaur, and Prince Verma. "An Improvement in Face Recognition for Invariant Faces." (2016).

[2]. Shah, Deepali H., Dr JS Shah, and DrTejas V. Shah. "The Exploration of Face Recognition Techniques." International Journal of Application or Innovation in Engg. And Management (IJAIEM) Web Site: www. ijaiem. org Email: editor@ ijaiem. org, editorijaiem@ gmail. com 3, no. 2 (2014).

[3]. Kadam, Kiran D. "Face Recognition using Principal Component Analysis with DCT." International Journal of Engineering Research and General Science, (2014) ISSN: 2091-2730.
[4]. Sodhi, Kuldeep Singh, and MadanLal. "Comparative analysis of PCA-based face recognition system using different distance classifiers." Int. J. of Appl. or Innovation in Eng. &Manag 2 (2013): 341-348.
[5]. Anila, S., and N. Devarajan. "Preprocessing technique for face recognition applications under varying illumination conditions." Global Journal of Computer Science and Technology 12, no. 11-F (2012).
[6]. Dharavath, Krishna, Fazal Ahmed Talukdar, and RabulHussainLaskar. "Improving face recognition rate with image preprocessing." Indian Journal of Science and Technology 7, no. 8 (2014): 1170-1175.
[7]. Parmar, Divyarajsinh N., and Brijesh B. Mehta. "Face Recognition Methods & Applications." arXiv preprint arXiv:1403.0485 (2014).
[8]. Milborrow, Stephen, John Morkel, and Fred Nicolls. "The MUCT landmarked face database." Pattern Recognition Association of South Africa 201, no. 0 (2010).
[9]. Ravi, S., and SadiqueNayeem. "A study on face recognition technique based on eigenface." International Journal of Applied Information Systems5, no. 4 (2013): 57-62.
[10]. Renke, Pradnya. "Automatic face recognition using principal component analysis and dct." Journal of Electronics and Communication Engineering, ISSN: 2278-2834.
[11]. Gawande, Mohit P., and Dhiraj G. Agrawal. "Face recognition using PCA and different distance classifiers." (2014). ISSN: 2278-8735.
[12]. Huang, Rui, Qingshan Liu, Hanqing Lu, and Songde Ma. "Solving the small sample size problem of LDA." In Pattern Recognition, 2002. Proceedings. 16th International Conference on, vol. 3, pp. 29-32. IEEE, (2002).