Enhancing Face Recognition using Average per Region

Basheer M. Nasef
Teaching Assistant
Dept of Computer and Systems Engineering,
Zagazig University, Sharkia, Egypt

Ibrahim E. Ziedan
Professor
Dept of Computer and Systems Engineering,
Zagazig University, Sharkia, Egypt

ABSTRACT

Face recognition is concerned with the problem of correctly identifying face images and assigning them to persons in a database. This finds many practical applications in, e.g., surveillance, identification systems and access control.

In this paper, a face recognition method, with moderate computational requirements while preserving an acceptable recognition rate, is proposed based on the "average" features of gray images. The advantage of using average matching is that the structure of the face is strongly represented in its description along with its algorithmic and computational simplicity that makes it suitable for hardware implementation. The proposed technique is tested on the ORL face database benchmark and compared to well-established face recognition algorithms, namely Histogram, Hybrid Histogram & Eigen value (HHE). The results show the superiority of the new method over these methods in terms of recognition accuracy and computational time.

General Terms

Pattern Recognition (face recognition), Average or mean of matrix elements.

Keywords

Image processing, average, face recognition, gray image.

1. INTRODUCTION

Government agencies are investing a considerable amount of resources into improving security systems as a result of recent terrorist events that dangerously exposed flaws and weaknesses in today's safety mechanisms. Badge or password-based authentication procedures are too easy to hack. While, biometrics represents a valid alternative, they suffer from drawbacks. Iris scanning, for example, is very reliable but too intrusive; fingerprints are socially accepted, but not applicable to non-consentient people. On the other hand, face recognition represents a good compromise between what's socially acceptable and what's reliable, even when operating under controlled conditions. In the last decade, face recognition has received extensive attention because of the potential applications such as identity authentication, access control and human–computer communication. As a result, many face recognition algorithms based on linear/nonlinear methods, neural networks, and wavelets have been proposed [1, 2].

The aim of face recognition, which is an important component of pattern recognition, is to automate the process of reading and recognizing face images in a costly effective manner.

Face recognition methods, based on intensity images, are categorized as follows [5]: Holistic matching methods which use the whole face region as the raw input to a recognition system. One of the most widely used representation of the face region is eigen pictures [1, 5, 6, 7, 8], which is based on Principal Component Analysis (PCA). Using PCA, many face recognition techniques have been developed: eigenfaces, which use a nearest neighbor classifier; feature-line-based methods, which replace the point-to-point distance with the distance between a point and the feature line linking two stored sample points; Fisher faces which use linear/Fisher discriminate analysis (FLD/LDA); Bayesian methods, which use a probabilistic distance metric; and SVM methods, which use a support vector machine as the classifier. Utilizing higher order statistics, independent-component analysis (ICA) is argued to have more representative power than PCA, and hence may provide better recognition performance than PCA. Being able to offer potentially greater generalization through learning, neural networks/learning methods have also been applied to face recognition. One example is the Probabilistic Decision-Based Neural Network (PDBNN) method and the other is the evolution pursuit (EP) method.

In feature-based matching methods, local features such as the eyes, nose, and mouth are first extracted and their locations and local statistics (geometric and/or appearance) are fed into a structural classifier. Earlier methods belong to the Feature-based matching methods, using the width of the head, the distances between the eyes and from the eyes to the mouth, etc, or the distances and angles between eye corners, mouth extreme, nostrils, and chin top. More recently, a mixture-distance based approach using manually extracted distances was reported. Without finding the exact locations of facial features, Hidden Markov Model (HMM) based methods use strips of pixels that cover the forehead, eye, nose, mouth, and chin reported better performance than by using the KL projection coefficients instead of the strips of raw pixels. One of the most successful systems in this category is the graph matching system, which is based on the Dynamic Link Architecture (DLA) Using an unsupervised learning method based on a self-organizing map (SOM), a system based on a conventional neural network (CNN) has been developed.

Hybrid methods are based on using both local features and the whole face region to recognize a face, as the human perception system uses. One can argue that these methods could potentially offer the better of the two types of methods.

In this paper, a face recognition method is proposed based on dividing the face image into regions and calculating, for each region, a row vector consisting of the average of region columns.

The proposed system is tested on a set of standard Olivetti Research Laboratory (ORL) face database [9] achieving 94% recognition rate. Compared to well-established face recognition algorithms, namely Discriminative Common Vectors (DCV), DF-LDA and Direct-LDA, the results show the superiority of the new method over these methods in terms of recognition accuracy and computational time.

The paper is organized as follows: Section 2 presents a background on the benchmark Database and the average value of image in matlab. In Section 3, the Pre-processing step necessary for the proposed method is presented. Then, the proposed algorithm is presented in Section 4. In Section 5, some experimental results are provided. Finally, Section 6 concludes the paper.

2. BACKGROUND

2.1 Database

In the face recognition problem, one or more human faces in difference kinds of images from scene are to be matched with the library, or database, of faces.

In this work, the standard Cambridge Olivetti Research Laboratory (ORL) database [9] is used to perform tests and comparison. It contains 400 images for 40 persons, with 10 images per person. There are variations in facial expression such as open, closed eyes, smiling, and frowning. The database also has diversity in facial details (with or without glasses), scale (up to 10%) and orientation (up to 20 degrees). The image size is 112×92 pixels. There is an average of 29 Histogram features extracted from each image (whole face).

2.2 Gray Image

In MATLAB®, a grayscale image is stored as a matrix, in which each element corresponds to one image pixel and its value determines the gray levels of that pixel, see Fig 1.

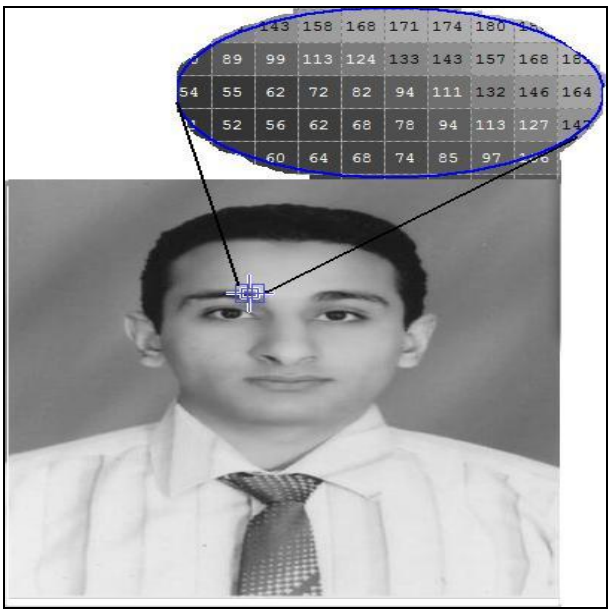

Fig 1. A gray image

3. PRE-PROCESSING

In this work, it suggested that each face is divided into five vertical strips and four horizontal stripes as shown in Fig 2. Therefore, each image has nine regions.

Fig 2. Each image is divided into nine regions

The images are then divided into two mutually exclusive sets: the training set (Face Database Image) and the test set (Input Image). The training set is used to initialize and prepare the system to recognize arbitrary images and to fine tuning the algorithm parameters. The test set is the set of images which is used to evaluate the performance of the system. It is important to use a training face database that includes images of same subject with different facial expressions.

The images are preprocessed to improve the recognition performance. After the preprocessing stage, all the new images should have the same dimension, so after cropping the face from the entire image, these new images are resized to 112 x 92 pixels to make them suitable for recognition purposes.

4. THE PROPOSED ALGORITHM:

Average per region

In this section, a face recognition algorithm is proposed to match an input image to one of the registered images in a database. The algorithm can be summarized as follows:

1 – Transpose the test image.

2- Divide the test image into 9 regions according to Fig 2.

3- For each region, find a row vector, avgt, consisting of the average gray-level in each column. avgt is of size 1 X (4*92+92).

3- Transpose the training images.

4- Divide the training image into 9 regions according to Fig 2.

5- For each region, find a row vector, avgd, consisting of the average gray-level in each column. avgd is of size 100 x (4*92+92), where 100 is the number of face in database. Note that each row corresponds to average over the nine regions of one face.

6- Calculate the Euclidean distance between the input and test images as

$$d(avgt , avgd) = Sqrt(\sum(avgt - avgd)^2),$$

where d is of size 9 x 100. Each column represent Euclidean distance between test image and one training image (i.e. d represents Euclidean distance between test image and 100 faces in database).

7 - Calculate average, avd, over d. Note that avd is of size 1 x 100.

8 - The image corresponding to the minimum value in avd is

the best match.

5. EXPERIMENTAL RESULTS

5.1 Analyzing The proposed Algorithm Procedure

A step by step output of average matching system is provided for the following two cases:

1) Case 1: Input image is the same as the registered image (i.e. the given image is in the database). The proposed recognition algorithm correctly recognizes the input image as shown in Fig 3.

Fig 3. Input image (left) and registered image (right). The average of Euclidean distance, avg, is 32.736.

2) Case 2: Input image is different from registered image (i.e. the given image is not in the database). As the given image is not in the database, the input image should be rejected, see Fig 4 and 5.

Fig 4. Input image (left) and registered image (right). The average of Euclidean distance, avg, is 52.5426.

Fig 5. Input image (left) and registered image (right). The average of Euclidean distance, avg, is 43.2526.

In order to find the best match in the given database, the average of the Euclidean distance of the input image to each of the 100 registered images are plotted in Fig 6. The minimum value of the average is considered the best match which, in this example, is 32.736 corresponding to the image in Fig 3.

Figure 7, show more experimental results.

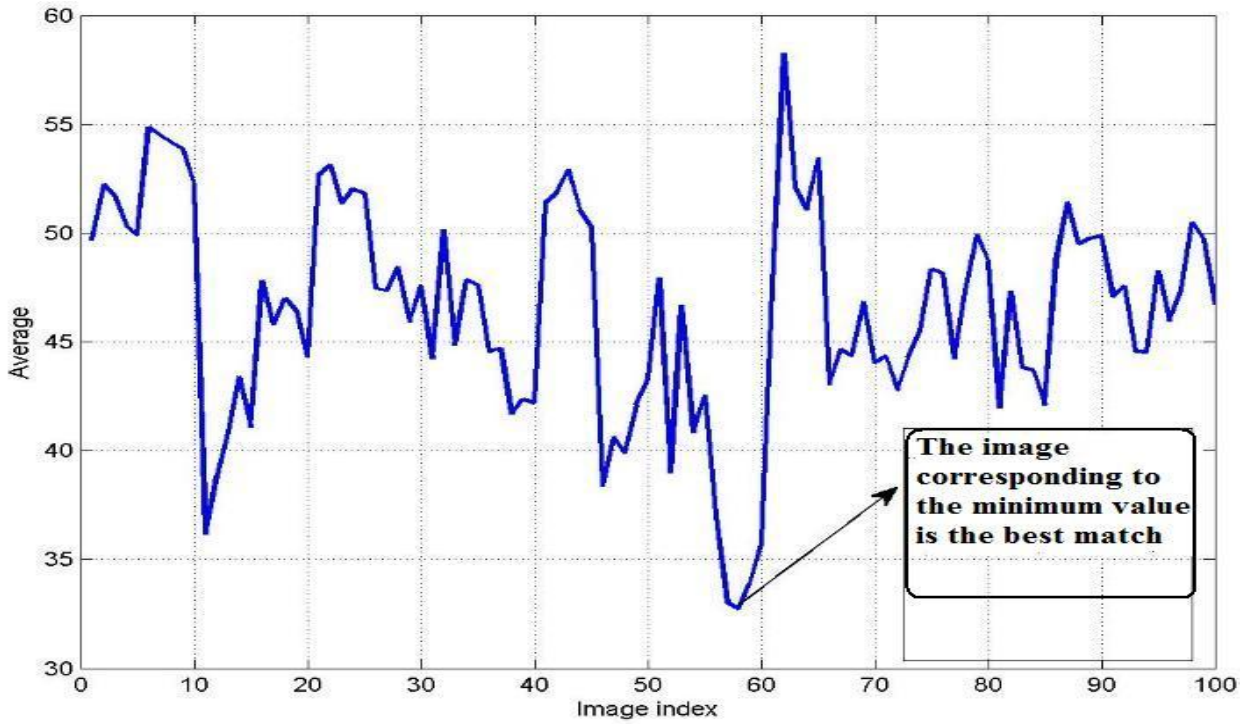

Fig 6. The average of Euclidean distance of the one input image to all 100 registered images in the database.

Fig 7. The SSE of the three different input images to all 100 registered images in the database.

This algorithm is tested using 100 images for 20 persons (5 images of different views for each person). The algorithm is able to correctly recognize the given face in all cases achieving a 100% recognition rate, where the recognition rate is calculated as the percentage of images detected correctly in all database images.

5.2 Comparison with some Recently Published Methods

In table 2, the proposed algorithm is compared to the Discriminative Common Vectors (DCV) [12], DF-LDA [14] and the Direct-LDA [13] algorithms. It can be seen that the proposed method achieves better recognition rate compared to these recently published algorithms.

Table 2: Comparing the proposed method to some recently published methods using the ORL database.

Method		Databases	Image size	Rec-rate (%)	Ref
Authors	Name				
Nasef and Ziedan (2012)	Proposed algorithm	ORL	112 X 92	**100**	
Heena Gulati (2012)	Hybrid Hist & Eigen value	ORL	112 X 92	**96.75**	[13]
Sar. Singh and M. Sharma (2012)	Hist	ORL	112 X 92	**95**	[14]

6. CONCLUSION

In this paper, a face recognition method is proposed. It divides the image into several regions vertically and horizontally. Then the average gray level are computed for each column, and then for each region. After that all regions are compared in the input and registered images. The registered image with the smallest Euclidian distance is considered the best match. The method is simple and yet attains very good recognition rate as shown on a standard ORL image database.

There are several points which need to be studied further such as setting a reasonable threshold values automatically according to the characteristics of the image, experimentation with pictures with non-ideal faces, or pictures taken by camera. Also, the algorithm needs to be tested for larger variation of database. The proposed system of face recognition may be applied in identification systems, document control and access control. In future work can be done on the neural network in which more than one image can be accurately recognized.

7. ACKNOWLEDGEMENT

The authors would like to thank Dr Ahmed Alenany, Dept of Computer and Systems Engineering, Zagazig University, Sharkia, Egypt, for his cooperation in keen viewing of this manuscript.

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9. AUTHOR'S PROFILE

Basheer M. Nasef was born in Elsharkia, Egypt in 1979. He received a B.Sc. degree in Computer and Systems Engineering from Alazher University, Egypt, in 2001, and a M.Sc. degree in Computer and Systems Engineering from Zagazig University, Egypt, in 2006. Currently, he is working towards PhD in Computer and Systems Engineering in the department of Computers and Systems Engineering, Zagazig University. His research interests include biometrics, pattern recognition, and database.

Dr Ibrahim E. Ziedan is a

Professor Emeritus and the head of the department of Computer and Systems Engineering, Zagzaig University, Egypt. His research interests include computer networks, image processing, pattern recognition, and control systems