Using the Edge Detector for Face Recognition Based on Eigenedge Faces Method

Hussein Abdullah Hameed
Department of physics, College of science, University of Kufa

Abstract
In this paper is designed a system capable to recognize and distinguish a human face on the others are located within the database, depending on the method of eigenedge faces, after the effect edge detection (Sobel operator), the system is running by the language of MATLAB. The comparison has been complete between the test image and the group of different images by criterion Minimum Mean distance.
Power system has been test on one of the problems can occur between the test image and the camera, in terms of the shift image (to the right, left, up and down) from the camera.

باستخدام الكشف حافي لتمييز الوجه المستند على طريقة حافات الوجوه الذاتية

حسين عبد الله حميد
قسم الفيزياء / كلية العلوم / جامعة الكوفة / العراق

الخلاصة
في هذا البحث صمم نظام قادر على التعرف وتمييز وجه إنسان عن الأخر الموجود ضمن قاعدة البيانات، معتمدا على طريقة حافات الوجوه الذاتية وذلك بعد تأثير الكشف الحافي (مؤثر سوبل) على الصورة، وتم إعداد هذا النظام بواسطة لغة الماتلاب.حيث تمت المقارنة بين الصورة المختبرة ومجموعة من الصور المختلفة بواسطة معيار معدل المسافة الصغرى.
وتم اختبار قوة النظام على احد المشاكل الممكن حدوثه بين الصورة المختبرة والكاميرا، من حيث إزاحة الصورة (نحو اليمين، نحو اليسار، نحو الأعلى ونحو الأسفل) عن الكاميرا.

1- Introduction

Face recognition has become an important issue in many applications such as security systems, credit card verification and criminal identification. The ability to model a particular face and distinguish it from a large number of stored face models would make it possible in vastly improve criminal identification.

The ability merely detects faces, as opposed to recognizing them, can be important. Detecting faces in photographs for automating color film development can be very useful, since the effect of many enhancement and noise reduction techniques depends on the image content. Although it is clear that people are good at face recognition, it is not at all obvious how faces are encoded or decoded by the human brain. Human

face recognition has been study for more than twenty years. Unfortunately developing a computational model of face recognition is quite difficult, because faces are complex, multi-dimensional visual stimuli. Therefore, face recognition is a very high-level computer vision task, in which many early vision techniques can be involved. [1]
The first step of human face identification is to extract the relevant features from facial images. Researchers have proposed many techniques of extracting features for face recognition purpose. In this paper, Eigenedge proposed in to extract the edges face map of a face is a computationally efficient method. This method has been apply to faces and has shown better performance over other edge and gray level based representations for variation in illumination for human faces.

2- Edge Detection

Edges are important features in an image since they represent significant local intensity changes. They provide important clues to separate regions within an object or to identify changes in illumination. Most remote sensing applications, such as image registration, image segmentation, region separation, object description, and recognition .Image edges is usually found where there is a sudden change in image intensity [2].
Edges widely exist between objects and backgrounds, objects and objects, primitives and primitives. The edge of an object is reflecting in the discontinuity of the gray. Therefore, the general method of edge detection is to study the changes of a single image pixel in a gray area, use the variation of the edge neighboring first-order or second-order to detect the edge. This method is using to refer as local operators edge detection method. Edge detection is mainly the measurement, detection and location of the changes in image gray. Therefore, edge extraction is an important technique in graphics processing and feature extraction. [2 3]

The Sobel operator is a kind of orthogonal gradient operator. Gradient corresponds to first derivative, and gradient operator is a derivative operator. For a continuous function f(x, y), in the position (x, y), its gradient can be expressed as a vector

$$\nabla f(x,y) = [G_x \ G_y] = \left[\frac{\partial G}{\partial x} \ \frac{\partial G}{\partial y}\right] \quad (1)$$

The partial derivatives of the formulas above need to calculate for each pixel location. In practice, we often use small area template convolution to do approximation. G_x and G_y need a template each, so there must be two templates combined into a gradient operator. The two 3x3 templates used by Sobel are showed as figure (1).
Every point in the image should use these two kernels to do convolution. One of the two kernels has a maximum response to the vertical edge and the other has a maximum response to the level edge. The maximum value of the two convolutions is using as the output bit of the point. [4 5]

-1	-2	-1
0	0	0
1	2	1

(a) G_x

-1	0	1
-2	0	2
-1	0	1

(b) G_y

Figure 1- Sobel Edge Operator

3- Principal Component Analysis

PCA is a method that projects a dataset to a new coordinate system by determining the eigenvectors and eigenvalues of a matrix. It involves a calculation of a covariance matrix of a dataset to minimize the redundancy and maximize the variance. Mathematically, PCA is defined as an orthogonal linear transformation and assumes all basis vectors are an orthogonal matrix. [6 8]
The PCA is computed by determining the eigenvectors and eigenvalues of the covariance matrix. The covariance matrix is used to measure how much the dimensions vary from the mean with respect to each other. The covariance of two random variables (dimensions) is their tendency to vary together as [6 7]

$$cov(x,y) = \sum_{i=1}^{N} \frac{(x_i-\bar{x})(y_i-\bar{y})}{N} \quad (2)$$

Where $\bar{x}$ = mean(x) and $\bar{y}$ = mean(y), where N is the dimension of the image.

4- Calculating Eigenedge Faces

Consider a set of P sample images $I^{p}_{r\times c}$, p= 1, 2, 3 …, P, with resolution r x c. Applying the edge effected (sobel operator) in eq (1) on the original images, the pixels in the image are

vectored into N -dimensional vector $Q_{P,}$ (N= r x c).
The vectors obtained in this manner from all the P sample images can be denoted as $A=[Q_1, Q_2, Q_3, \ldots \ldots, Q_P]$ For a given set of N -dimensional vector representation of edge faces, The principal component analysis is found the vectors that best account for the distribution of edge face images within the entire images space. These vectors define the subspace of edge face images, which we call "edge face space". Each vector is of length N^2. Because these vectors are the eigenvectors of the covariance matrix corresponding to the edges face images, we refer to them as "eigenedge face". [9 10] By using eq (2), and eq (3)

$$C\, e_i = \lambda_i\, e_i \qquad (3)$$

λ_i is the eigenvalues associated with the eigenvectors e_i . Eigenvectors of the covariance matrix of the edge faces are referred as eigenedge faces.

5- Experimental Results

Let have 10 - samples of training face images, shown in figure (2), each face image is resized to 128x128 pixels size and have gray level.

(1) (2) (3) (4) (5)

(6) (7) (8) (9) (10)

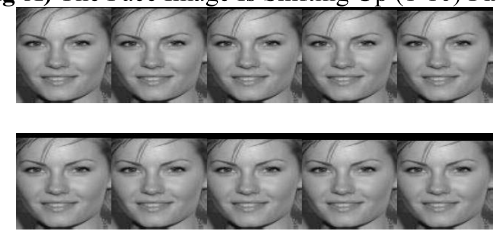
Figure 2- Training Set Of Face Images

The edges faces are calculated as described in Section 2 (sobel operator) of the all-training images, there are placed within database, and then compute eigenvalues and eigenvectors for convenience matrix eq (3) that contained edges face vectors. To chose no allotment, the image in fig (2 (6)) is the test image By utilizing minimum mean distance to measured The similarity between the stored images and the test image in the eigenedge faces space. Given by eq (4) [11]

$$MMD = Min\ \{ \sum_{i=1}^{m-1} \sum_{k=1}^{m} | V_{m,k} - V_{i,k} | \} \qquad (4)$$

Where: "i" represents the vector indexing number, and "k" is the vector's elements number. This paper is focused on the problems between the camera and object, as shown (figure 3).

(Fig-A) The Face Image Is Shifting Up (1-10) Pixels.



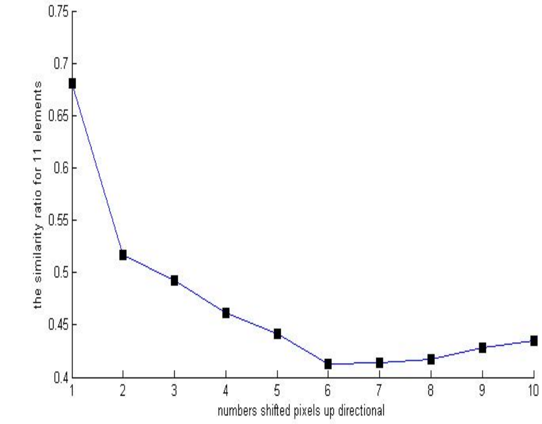
(Fig-B) The Face Image Is Shifting Down (1-10) Pixels.

(Fig-C) The Face Image Is Shifting Right (1-10) Pixels.

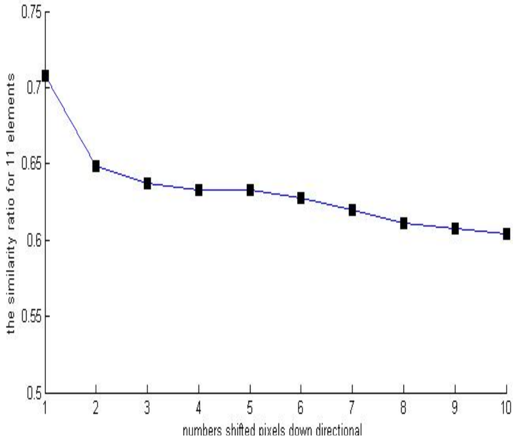
(Fig-D) The Face Image Is Shifting Left (1-10) Pixels.

Figure 3- The Face Image Is Moving Up, Down, Right, Left (1-10) Pixels From The Camera.

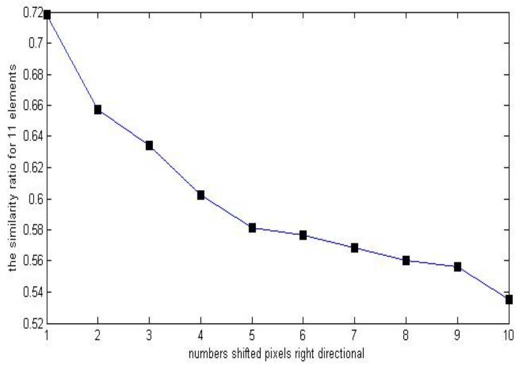
The results of similarity ratio are as shown in (figure 4).



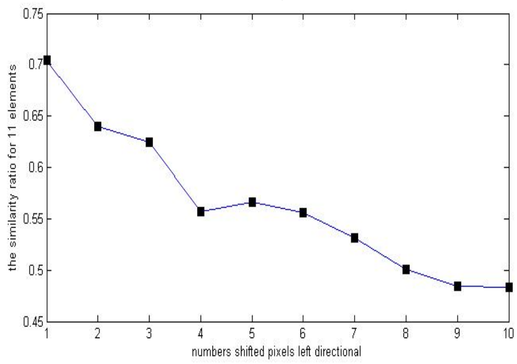
Shifted Effect Up Direction



Shifted Effect Down Direction



Shifted Effect Right Direction



Shifted Effect Left Direction

Figure 4- Represents The Similarity Ratio (Test Image) For 11 Elements.

To increasing the similarity ratio for test image, it is reduced 11 to 6 elements as shown (figure 5).

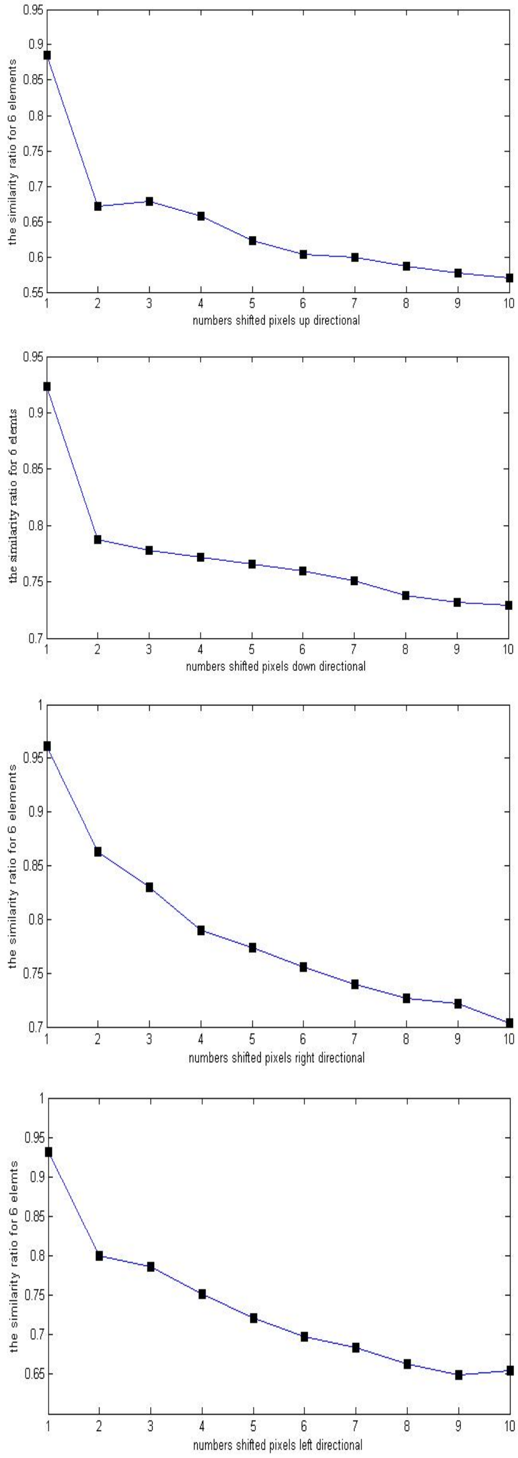


Figure 5- Represents The Similarity Ratio (Test Image) For Six Elements.

This method can be identifying enhancement for test image as shown results (fig -6-)

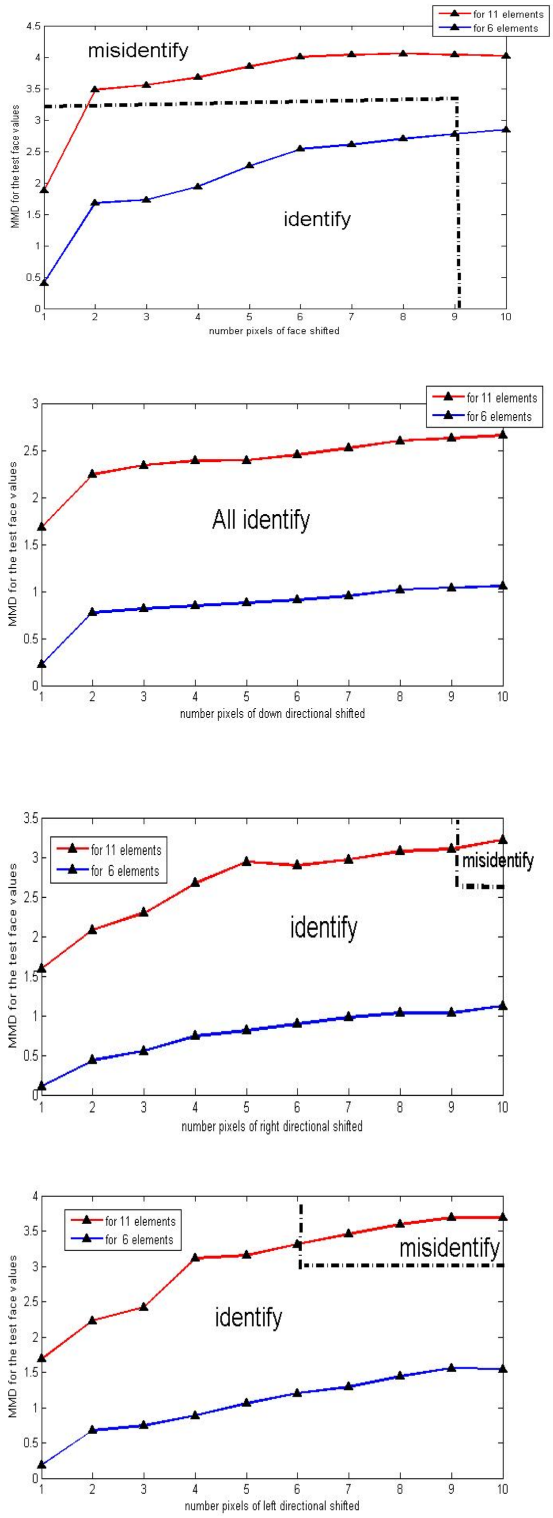


Figure 6-Represents The Different Eigenedge Face Method For 11 Elements And 6 Elements.

6- Conclusions

The test image has been moved (i.e. up, down, right and left) by distance ranges of 10 pixels, it was different verification and similarity ratio (i.e. up shift (0.4 -0.67), down (0.62-0.72), right (0.54 -0.72), left shift (0.5 -0.7)) for 11 elements. The similarity ratio is increased because the elements eigenvectors are decreased (11 to 6) elements. It becomes (i.e. up shift (0.57 -0.87), down (0.73-0.93), right (0.7 -0.96), left shift (0.65 -0.93)) for 6 elements. The increasing of similarity ratio makes test image most verification for more ranges of shifting in all the directions (up, down, right and left).

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