

Images Recognition Using Eigenvectors Based Distributed Features

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Abstract

In this paper, system has been presented to recognize RGB and gray images based on Eigenvector. In the approach, we used images to extract and store the Eigenvectors and Eigenvalues. The Eigenvectors for the train images were computed and calculate the weights, we select some of these vectors with its weights as a features depending on the maximum of Eigenvalues. and Finally, the input image was recognized when similarity was obtained by calculating the minimum Euclidean distance between the test image and the different images. Numbers of experiments are done to evaluate the performance of images recognition system.

Keywords— Eigenvectors; Eigenvalues ; Eigenimages; PCA

Introduction

Growing information technology today has produced many different applications using a color image as a source of information. Image processing and analysis is concerned with the manipulation of digital images on a computer utilizing digital signal processing techniques. Like most advanced signal processing techniques there are a lot of work has been done on the affective recognition of expressions which holds the major key in the human-machine interaction. The research on the color and gray images across different

cultures points out that the recognition of expressions is universal and established as constant across cultures^(1,2)

In recent years, a lot of works has been done images recognition, some of them depending on human face as a shape (eyes , skin, ... ,ect) or as an affective recognition of expressions or feeling and its reaction on human which holds the major key in the human -machine interaction. The first suggestion of expression of emotions as universal was given by Charles Darwin⁽²⁾ in his contriving work build from his theory of

evolution. There are many research confirmed the big difference between facial expressions and the inability to discrimination and this is due to the difference in the psychological state of a person, for example, a happy person face differs from sad person. On the other hand colors space shared in the recognition because RGB (Red, Green, Blue) domain reduce the probabilities of mistakes because it has a wide space of colors on the reverse grayscale images that limit the colors and make them restricted to the gradients between the white and black^(2,3)

In this paper, a method has been presented to design an Eigenvector based color and gray images recognition system. Eigenvector based features are extracted from the images. In the training phase, a set of 50 images for each basic expression is processed and Eigenvectors specific to the expressions are stored. In the testing phase, the Eigenvector of the testing image is computed and the Euclidean distance of the Eigenvector of the testing image and all the stored Eigenvector is computed (more than 100 images). The testing image is classified the Euclidean distance

between the Eigenvectors of that expression and the Eigenvectors of the testing image is obtained minimum compared to the Eigenvectors of the other expressions. To make the system more efficient instead of the whole image.

Image processing field is becoming more popular for the security purpose in now days. It has many sub fields and image recognition is one from them. Many techniques have been developed for the image recognition but in our work we just discussed prevalent technique Image PCA (Principal Component Analysis)^(2,4).

In PCA, a training set is formed by collecting some images. The Eigenvectors of all the images are calculated are the linear combination of these Eigenvectors. Mathematically images are the Eigenvectors of the covariance matrix of the database. These Eigenvectors represents the significant variations among the images. Weights of the Eigenvectors are calculated for classification. When a new image is to be recognized, the Euclidian distance between test image and the database are calculated and are classified .

A.Eigenvectors And Eigenvalues^(1,5)

In linear algebra, the Eigenvectors of a linear operator are non-zero vectors which, when operated on by the operator, result in

a scalar multiple of them. The scalar is then called the Eigenvalue (λ) associated with the Eigenvector(X).

Eigenvector is a vector that is scaled by a linear transformation. It is a property of a matrix. When a matrix acts on it, only the vector magnitude is changed not the direction.

$$\mathbf{AX} = \lambda \mathbf{X} \quad (1)$$

Where $\mathbf{A}$ is a matrix

As in example :

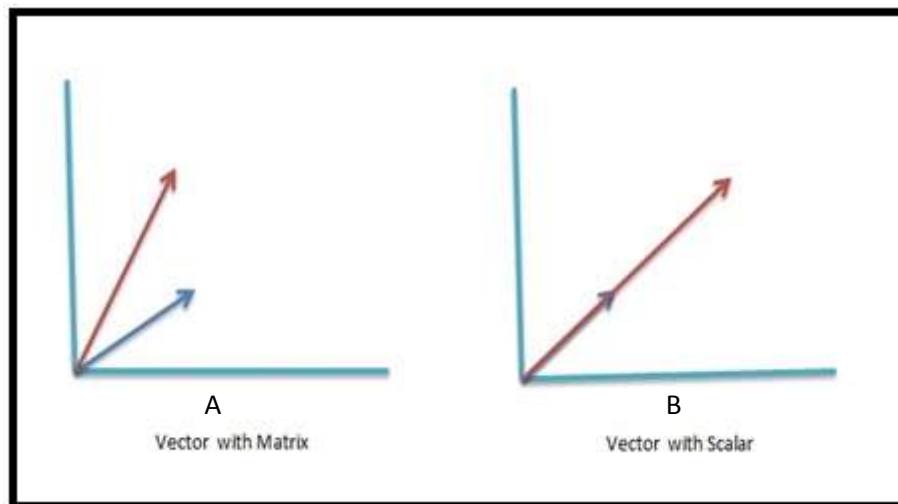
$$\mathbf{A} = \begin{bmatrix} 5 & 2 \\ 3 & 6 \end{bmatrix}$$

$$\mathbf{X} = \begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

$$\lambda = 8$$

$$\begin{bmatrix} 5 & 2 \\ 3 & 6 \end{bmatrix} * \begin{bmatrix} 2 \\ 3 \end{bmatrix} = 8 * \begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

These situation effect on the direction and length of any vector if it multiply with matrix while if using (scalar) it affect only on the length of vector (increase or decrease) depending on the value of scalar (if the scalar >1 the vector length is increasing else is decreasing) as the following Figure (1).



Figure(1) The Figureure show the effect of multiply

a.Vector with Matrix

b.Vector with Scalar

B. Calculations Of Eigenvalues And Eigenvectors^(1,7,8):

By using equation(1), following equation has been derived

$$(\mathbf{A} - \lambda \mathbf{I})\mathbf{X} = \mathbf{0} \quad (2)$$

Where $\mathbf{I}$ is the $n \times n$ Identity matrix. This is a homogeneous system of equations, and from fundamental linear algebra, it has

been proved that a nontrivial solution exists if and only if.

It should immediately be clear that, no matter what $\mathbf{A}$ and λ are, the vector $\mathbf{x} = \mathbf{0}$ (that is, the vector whose elements are all zero) satisfies this equation.

$$\mathbf{D}(\mathbf{A} - \lambda \mathbf{I}) = \mathbf{0} \quad (3)$$

Where D denotes determinant. When evaluated, becomes a polynomial of degree n . This is known as the characteristic equation of A , The characteristic polynomial is of degree n . If A is $n \times n$, then there are n solutions or n roots of the characteristic polynomial. Thus there are n Eigenvalues of A satisfying the equation,

C. Principle Component Analysis^(2,4)

PCA is the simplest of the true Eigenvector based multivariate analysis. Mathematically, it is an orthogonal linear transformation that transforms the data to a new coordinate system. The use of Eigenimage and vectors is commonly called as Principal Component Analysis. With PCA, the image must be used of same size and they are normalized to a particular size for the usage. In PCA, dimension of data is reduced and decomposes the image structure into orthogonal and uncorrelated components which are the Eigenimage. The image can be represented as a weighted sum of the Eigenimages. Mathematically, principal component analysis approach converts a set of correlated variables into a set of linearly uncorrelated variables. Each image in the training set contributes to the Eigenvectors. This can be displayed as an Eigenimage expresses the data in such a way as to highlight the similarities and differences.

$$A X_i = \lambda X_i \quad (4)$$

Where $i=1, 2, 3, \dots, n$ If the Eigenvalues are all distinct, there are n associated linearly independent Eigenvectors, whose directions are unique, which span an n dimensional Euclidean space.

When the new image to be recognized its Eigenvalue and weights are calculated. Then these weights are compared with the weights of the known images in the training set. It is done by calculating the Euclidian distance between the new image and the images in training set. If the Euclidian distance is minimum, then the image is known and if it is maximum, then the image is unknown.

D. The Algorithm steps

So we can summarize the algorithm in a steps to know the primary points in this papers then we discuss them .

The algorithm had five steps , as the following:-

Step1 (prapering the images) :

First the Input is detected by the Digital camera for natural views, the Camera has 16 MB with resolution 2988 x 5312 pixel , LED flash. Each image was taken Ten shots at the same time without any movement.

Step2 (training set & features extraction & calculate the weights) :

Then images processed as in fig (2) to find the Eigenvector and Eigenvalues, after that we sorted the Eigenvalues descending , and we chose the 10 higher values with its Eigenvectors from them (the total is 50) , because higher values have the maximum affects on the images , that called the features, then calculate the weight creat the database.

Step3: (recognition steps): Matching is done, New input image (testing image) must apply all the pervious processing (step2) and then compute the Euclidian distains between the eigenvector for input image and the database (training images).

Step4: If the input image is matched with the database image then image is recognized. If image is not matched then goes to database and take second image.

Step 5: Image is recognized.

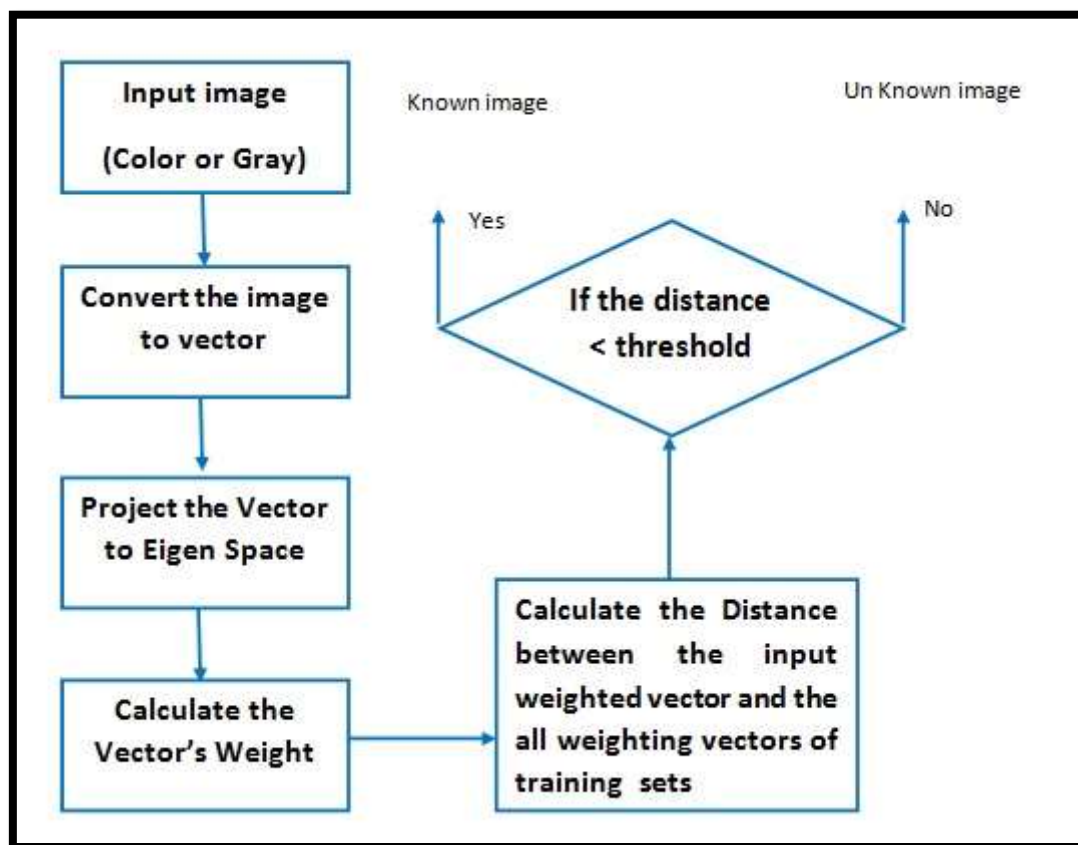


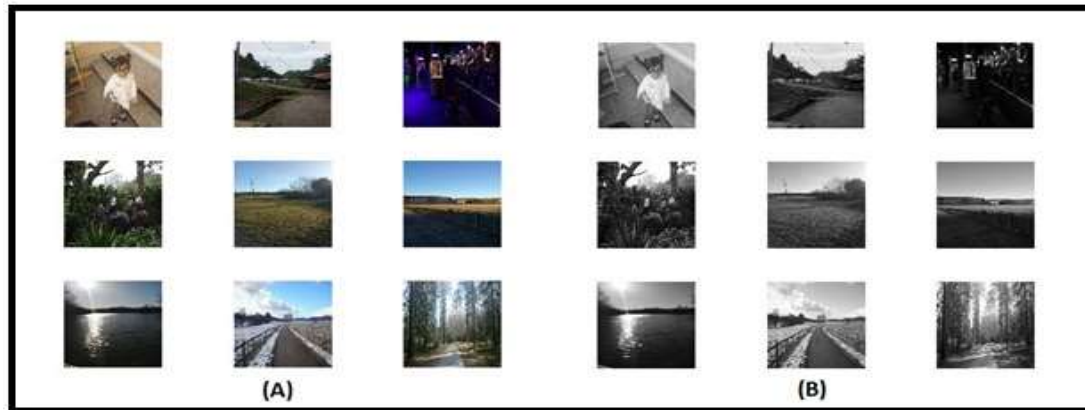
Figure (2) Principle Component Analysis

E. Training Set

A training set is formed by combining different images. In our paper we discuss both Images space (color (RGB) and gray). The images of all the different individuals

were collected in a set called the training set. Images are collected from different type of sources. The sources may be video

camera or images database. Sample of training set fig (3).



Figure(3) Example for training set (RGB (A) and gray(B))

F. Features Extraction

After Extract the Eigenvectors and Eigenvalues , we determined the Ten larger values of Eigenvalues with its Eigenvectors from the total (50 values) and consider its as features because these values have the more effect in the set of images ^(4,8).

G. Weight Vector^(1,5)

For recognition, weight of the largest Eigenimages is calculated from the training image. When the new image to be recognized, we calculate the weights associated with the Eigenimages, which linearly approximate the image or can be used to reconstruct the image. Now these weights are compared with the weights of the known images so that it can be recognized as a known image or unknown image.

H. Euclidian Distance^(2,6,8)

In mathematics, the Euclidean distance or Euclidean metric is the ordinary distance between two points that one would measure with a ruler, and is given by the Pythagorean formula. By using this formula as distance, Euclidean space (or even any inner product space) becomes a metric space. The associated norm is called the Euclidean norm. The Euclidean distance between point's p and q is the length of the line segment connecting them. Here we use the Euclidian distance to compare the training images and input image (in both application color and gray). We calculate the Euclidian distance between the input image and training image . Known image is with minimum Euclidian distance and unknown image with largest distance.

$$D(xi, xj) = \sqrt[2]{\sum_{r=1}^n (ar(xi) - ar(xj))^2} \quad (5)$$

I. Experimental Results

The experiment is done using matlab simulator. First the training set is created with images. The training set consists of 200 images(100 RGB , 100 gray). The images are taken under normal light conditions (using Camera high resolutions). Varying conditions such as lighting has minimal effect on recognition process. The input image is read by using matlab and is recognized from the training set and the total elapsed time is calculated (30 second for RGB 20 second for gray).

The system resolved problem about the different in size and simulated using

matlab and it shows appreciable result and faster detection rate. The approach is definitely simple, easy and faster to implement,(The recognition ratio for RGB images is 96% and in gray images is 94% that for testing images ,as for the training images the recognition ratio is 100% for the Two Types(RGB & gray)).

The results are shown in Tables (2) and (3) , Table (2) for color images and Table(3) for gray images, but before we discuss them , it is necessary to explain the codes that appear in Tables (2) and (3), Table(1) give the codes for the images.

Table (1) The Images Codes

Image	Values
Image1	1,2,3,4,5
Image2	6,7,8,9,10
Image3	11,12,13,14,15
Image4	16,17,18,19,20
Image5	21,22,23,24,25
Image6	26,27,28,29,30
Image7	31,32,33,34,35
Image8	36,37,38,39,40
Image9	41,42,43,44,45
Image10	46,47,48,49,50

As in table (1) , We determined that the image 1 or 2 or...ect depending on the values appeared in the Table(2) or Table (3) (if the value is 1 or 2 or 3 or 4 or 5 then the image is the first one , 6 or 7 or 8 or 9 or 10 for the second image and so on).

The (indx) mean the arrange of testing images (these images not the same Images the system trained on it).

The shaded cells consider the wrong items ,The system give it the error values depending on the similarity between

images , or the tiny movement that evident during the stirring
happened during taken pictures and that imagery.

Table (2) results of color Images recognition

Indx Image	Indx6	Indx7	Indx8	Indx9	Indx10
Image1	5	5	5	5	5
Image2	10	10	10	10	10
Image3	11	11	12	12	15
Image4	19	19	19	19	19
Image5	21	25	25	24	23
Image6	29	28	30	27	29
Image7	33	35	35	35	34
Image8	40	38	38	38	40
Image9	41	48	41	49	42
Image10	47	49	46	49	46

Table (3) results of gray Images recognition

Indx Image	Indx6	Indx7	Indx8	Indx9	Indx10
Image1	5	5	5	5	5
Image2	10	10	10	10	10
Image3	13	13	12	12	15
Image4	19	19	19	19	19
Image5	24	21	23	23	23
Image6	26	28	30	27	26
Image7	31	31	31	31	31
Image8	38	38	37	38	38
Image9	41	35	30	30	42
Image10	47	49	46	49	46

J. Conclusion

The system had given a good results is 96% for RGB images and 94% for gray images that for testing images ,as for the training images the recognition ratio is 100% for the Two Types(RGB & gray)), The reasons of the errors that got in the results are the similarity between the images, as we mentioned that the pictures were taken of landscapes(natural views) as much as trying to prevent the changes that occur when the pickup.

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تمييز الصور باستخدام المتجهات الذاتية بالاعتماد على الصفات الموزعة

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الملخص

يقدم هذا البحث نظاماً لتمييز الصور الملونة والرمادية بالاعتماد على المتجهات الذاتية. في هذه الطريقة يتم استخدام صور لاستخراج وتخزين المتجهات الذاتية والقيم الذاتية. يتم حساب المتجهات الذاتية للصور المخصصة للتدريب وحساب الأوزان لها، واختيار جزء منها كصفات بالاعتماد على أعلى قيم للقيم الذاتية، وفي النهاية الصورة المدخلة المراد تمييزها تجري عليها نفس المعالجات ثم حساب أقل مسافة إقليدية بين صورة الاختبار وباقي الصور المختلفة. العديد من التجارب تم تطبيقها لتقييم أداء نظام تمييز الصور.

الكلمات المفتاحية :- المتجهات الذاتية ;القيم الذاتية;الصور الذاتية;تحليل المكونات الأساسية