An Identification of Persons Utilizing the Prosperities of the Eyes

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Abstract:

Previously, and up to now the fingerprint was used in identification the persons, but with the development of the sciences and complications of the life it was necessary to refer to other parts of the human body such as the parts of the eyes which is under our considerations.

There are many methods used to distinguish persons from each other using fingerprints, via vibration of sound waves, through the shape of the ear, the color of the eyes and the iris. But in this research the geometrical relationship between the eyes for each person in which differs from one to another was found. Also, it can be find more than a geometrical relationship between the eyes in order to have more than geometrical properties and the relation between them and take these relationships as database information in order to compare with other wanted properties.

In this paper, a DB technique was used which contains all eyes geometrical parameters. Practically, a good results more than 85% was found.

1- Introduction

Identification of persons is a method of identify a person based on physiological or behavioral characteristic. Among the features measured are face, fingerprints, hand geometry, handwriting, iris, retinal, vein, and voice. Biometric technologies are becoming the foundation of an extensive array of highly secure identification and personal verification. As the level of security, the need for highly secure identification and personal verification technologies is becoming apparent [1].

In this paper, some of the existing methods are used to deal with digital images starting by a very basic approach of digital image processing such as gray scale, threshold which is an important role in many applications of image processing, and digital filters.

2- Image Representation By Using Gray Scale

The digital image I(r,c) is represented as a two-dimensional array of data, where each pixel value corresponds to the brightness of the image at the point (r,c) [2]. Gray-scale images are referred to as monochrome, or one-color, images. They contain brightness information only, no color information. The number of bits used for each pixel determines the number of different brightness levels available [3]. The typical image contains 8 bits/pixel data, which allow us to have 256 (0-255) different brightness (gray) levels. This representation provides more than adequate brightness resolution, in terms of the human visual system's requirements, and provides a "noise margin" by allowing for approximately twice as many gray levels as required. This noise margin is useful in real-world applications because of the many different types of noise (false information in the signal) inherent in real system. Additionally, the 8-bit representation is typical due to the fact that the byte, which corresponds to 8-bits of data, is the standard small unit in the world of digital computers [3].

For every day use, the effective luminance of a pixel is calculated with the following formula:

$$Y = 0.299R + 0.587G + 0.114B \qquad (1)$$

This luminance value can then be turned into a grayscale pixel using color. From a rgb(Y,Y,Y).

3-Edge Detection

The sobel edge detection mask look for edges in both the horizontal and vertical directions and then combine this information into a single metric. The masks are as follows:

$$\text{Row mask} \quad \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} \qquad \text{Column mask} \quad \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

Figure (1): Edge detection mask.

These masks are each convolved with the image. At each pixel location we now have two numbers: s1, corresponding to the result from the row mask, and s2, from the column mask we use these numbers to compute two metrics, the edge magnitude and the edge direction, which are defined as follows: [4]

Edge magnitude

$$E = \sqrt{s1^2 + s2^2} \qquad \text{(2)}$$

Edge direction

$$E1 = \tan^{-1}\left[\frac{S_1}{S_2}\right] \qquad \text{(3)}$$

4- Thinning

An important approach for representing the structural shape of a plane region is to reduce it to a graph. This is often accomplished by obtaining the skeleton of the region via a thinning. (also called Skeltonizing)algorithms [5].

Thinning procedures play a central role in a broad range of problems in image processing. This algorithm is present for thinning binary regions. In the following discussion it is assumed that region points have value 1 and background points have value 0. the method consists of successive passes of two basic steps applied to the contour points of the given region. Where a contour point is any pixel with value 1 and have at least one 8- neighbor valued 0. as show in the following figure: [5,6]

P_0	P_2	P_3
P_8	P_1	P_4
P_7	P_6	P_5

Figure (2): Neighborhood arrangement used by the thinning algorithm.

The first step flags a contour point P for deletion if the following conditions are satisfied:

a) $2 \leq N(P_1) \leq 6$,
b) $S(P_1) = 1$,
c) $P_2 \cdot P_4 \cdot P_6 = 0$, ... **(4)**
d) $P_4 \cdot P_6 \cdot P_8 = 0$,

Where $N(P_1)$ is the number of nonzero neighbors of P_1 :that is:-

$$N(P_1)= P_2 + P_3 + \ldots\ldots\ldots + P_8 + P_9 \quad \text{.....................} \quad (5)$$

And $S(P_1)$ is the number of 0-1 transitions in the ordered sequence of P_2, P_3, ….., P_8,P_9.

In the second step, conditions a and b remain the same, but conditions c and d are changed to

c') $P_2 \cdot P_4 \cdot P_8 = 0$,

d') $P_2 \cdot P_6 \cdot P_8 = 0$.

Step 1: is applied to every border pixel in the binary region under consideration. If one or more of the conditions (a) through (d) are violated, the value of the point in question is not changed. If all conditions are satisfied the point is flagged for deletion. It is important to note, however, that the point is not deleted until all border points have been processed. This prevents changing the structure of the data during execution of the algorithm. After step 1 has been applied to all border points, those that were flagged are deleted (i.e. changed to 0). Then,

Step 2: is applied to the resulting data in exactly the same manner as step 1.

So, one iteration of the thinning algorithm consists of :-

1- **Applying step 1 to flag border points for deletion.**
2- **Deleting the flagged points.**
3- **Applying step 2 to flag the remaining border points for deletion.**
4- **Deleting the flagged points. This basic procedure is applied iteratively until no further points are deleted, at which time the algorithms terminates, yielding the Skelton of the region [5].**

5-Median Filter

In image processing it is usually necessary to perform a high degree of noise reduction in an image before performing higher-level processing steps, such as edge detection. The median filter is a non-linear digital filtering technique, often used to remove noise from images or other signals. The idea is to examine a sample of the input and decide if it is representative of the signal. This is performed using a window consisting of an odd number of samples. The values in the window are sorted into numerical order; the median value, the sample in the center of the window, is selected as the output.

The oldest sample is discarded, a new sample acquired, and the calculation repeats [7].

The median filter is also a sliding-window spatial filter, but it replaces the center value in the window with the median of all the pixel values in the window. As for the mean filter, the kernel is usually square but can be any shape. An example of median filtering of a single 3x3 window of values is shown below.

unfiltered values		
6	2	0
3	97	4
19	3	10

Figure (3a): Median filter of a single 3X3 window [7].

in order:

0, 2, 3, 3, 4, 6, 10, 15, 97

.

median filtered		
*	*	*
*	4	*
*	*	*

Figure (3b): Median filter of a single 3X3 window.

Center value (previously 97) is replaced by the median of all nine values (4).

Note that for the first (top) example, the median filter would also return a value of 5, since the ordered values are 1, 2, 3, 4, 5, 6, 7, 8, 9. For the second (bottom) example, though, the mean filter returns the value 16 since the sum of the nine values in the window is 144 and 144 / 9 = 16. This illustrates one of the celebrated features of the median filter: its ability to remove 'impulse' noise (outlying values, either high or low). The median filter is also widely claimed to be 'edge-preserving' since it theoretically preserves step edges without blurring. however, in the presence of noise it does blur edges in images slightly [7].

6 – Binarization

The digital image I(r,c) is represented as a two-dimensional array of data, where each pixel value corresponds to the brightness of the image at the point (r,c). Binary images are the simplest type of images and can take on two values, typically black and white, or '0' and '1'. A binary image is referred to as a 1 bit/pixel image because it takes only 1 binary digit to represent each pixel [4].

Binary images are often created from gray-scale image via a threshold operation, where every pixel above the threshold value is turned white ('1'), and those below it are turned black ('0') [4].

Several different methods for choosing a threshod exist; one method that is relatively simple, does not require much specific Knowledge of the image are shown in the following steps [7]:

1. **An initial threshold (T) is chosen, this can be done randomly or according to any other method desired.**
2. **The image is segmented into object and background pixels as described above, creating two sets:**
   1. **G_1 = {f(m,n):f(m,n)>T} (object pixels)**
   2. **G_2 = {f(m,n):f(m,n)T} (background pixels) (note, f(m,n) is the value of the pixel located in the m^{th} column, n^{th} row)**
3. **The average of each set is computed.**
   1. **m_1 = average value of G_1**
   2. **m_2 = average value of G_2**
4. **A new threshold is created that is the average of m_1 and m_2**
   1. **$T' = (m_1 + m_2)/2$**

5. Go back to step two, now using the new threshold computed in step four, keep repeating until the new threshold matches the one before it (i.e. until convergence has been reached).

7- Region growing and shrinking

Region growing and shrinking methods segment the image into regions by operating principally in the rc-based image space. Some of the techniques used are local, in which small areas of the image are processed at a time; others are global, with the entire image considered during processing. Methods that can combine local and global techniques, such as split and merge, are referred to as state space techniques and use graph structures to represent the regions and their boundaries. In general, the split and merge technique proceeds as follows [6]:

1- Define a homogeneity test. This involves defining a homogeneity measure, which may incorporate brightness, color, texture, or other application-specific information, and determining a criterion the region must meet to pass the homogeneity test.
2- Split the image into equally sized regions.
3- Calculate the homogeneity measure for each region.
4- If the homogeneity test is passed for a region, then a merge is attempted with its neighbors(s). if the criterion is not met, the region is split.
5- Continue this process until all regions pass the homogeneity test.

8- Mathematical Model

In this paper, suggest to use mathematical model to find many parameters which is used to distinguish eyes from one person to another, as shown in the following steps:-

Step 1:- find a center for each objects (eyes) according to the following:-

$$Xcen = \frac{X\min + X\max}{2} \qquad \text{.........} \qquad (6)$$

$$Ycen = \frac{y\min + y\max}{2} \qquad \text{.........} \qquad (7)$$

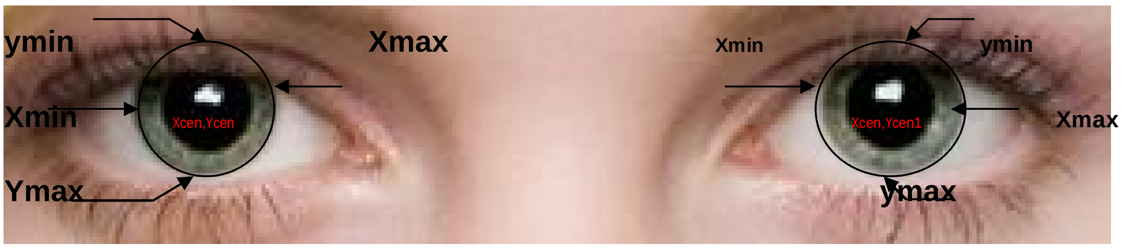

Figure (4): The representation of eye segment.

Step2:- Find the distance between two objects (eyes) according to the followings equations:-

$$\text{Distance} = \sqrt{(X_{cen1} - X_{cen2})^2 + (y_{cen1} - y_{cen2})^2} \quad \text{(8)}$$

$$\text{Dis1} = \sqrt{(X_{cen1} - X_{cen2})^2 + (y_{cen1} - y_{\min})^2} \quad \text{(9)}$$

$$\text{Dis2} = \sqrt{(X_{cen1} - X_{cen2})^2 + (y_{cen1} - y_{\max})^2} \quad \text{(10)}$$

$$\text{Dis3} = \sqrt{(Dis_1)^2 + (Distance)^2} \quad \text{(11)}$$

$$\text{Dis4} = \sqrt{(Dis_2)^2 + (Distance)^2} \quad \text{(12)}$$

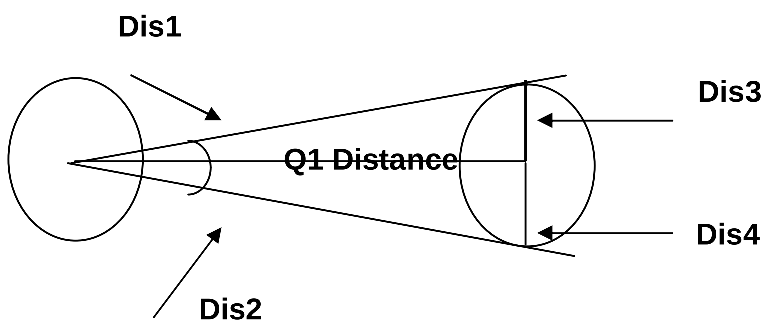

Figure (5): The graphical representation of eye segment of the right side.

Step3:- find the angle between two lines, one between Dis_1 & Distance called Q_1 and second between Distance & Dis_2 according to the following equations:-

$$Q = \tan^{-1} \frac{opposite}{adjecent} \qquad (13)$$

$$Q_1 = \tan^{-1} \frac{Dis_3}{Distance} \qquad (14)$$

$$Q_2 = \tan^{-1} \frac{Dis_4}{Distance} \qquad (15)$$

$$Qall = Q1 + Q2 \qquad (16)$$

Step4:- Repeat steps 1,2,3 to the second side of the face as shown in the following figure:-

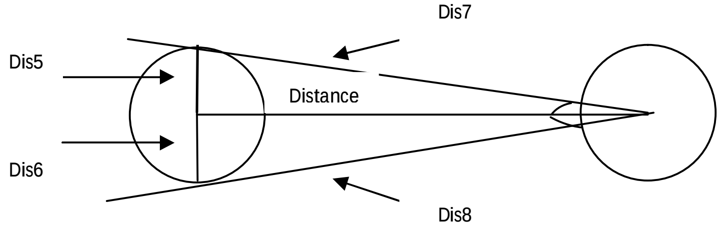

Figure (6): The graphical representation of eye segment of the left side.

9- System Model (block diagram)

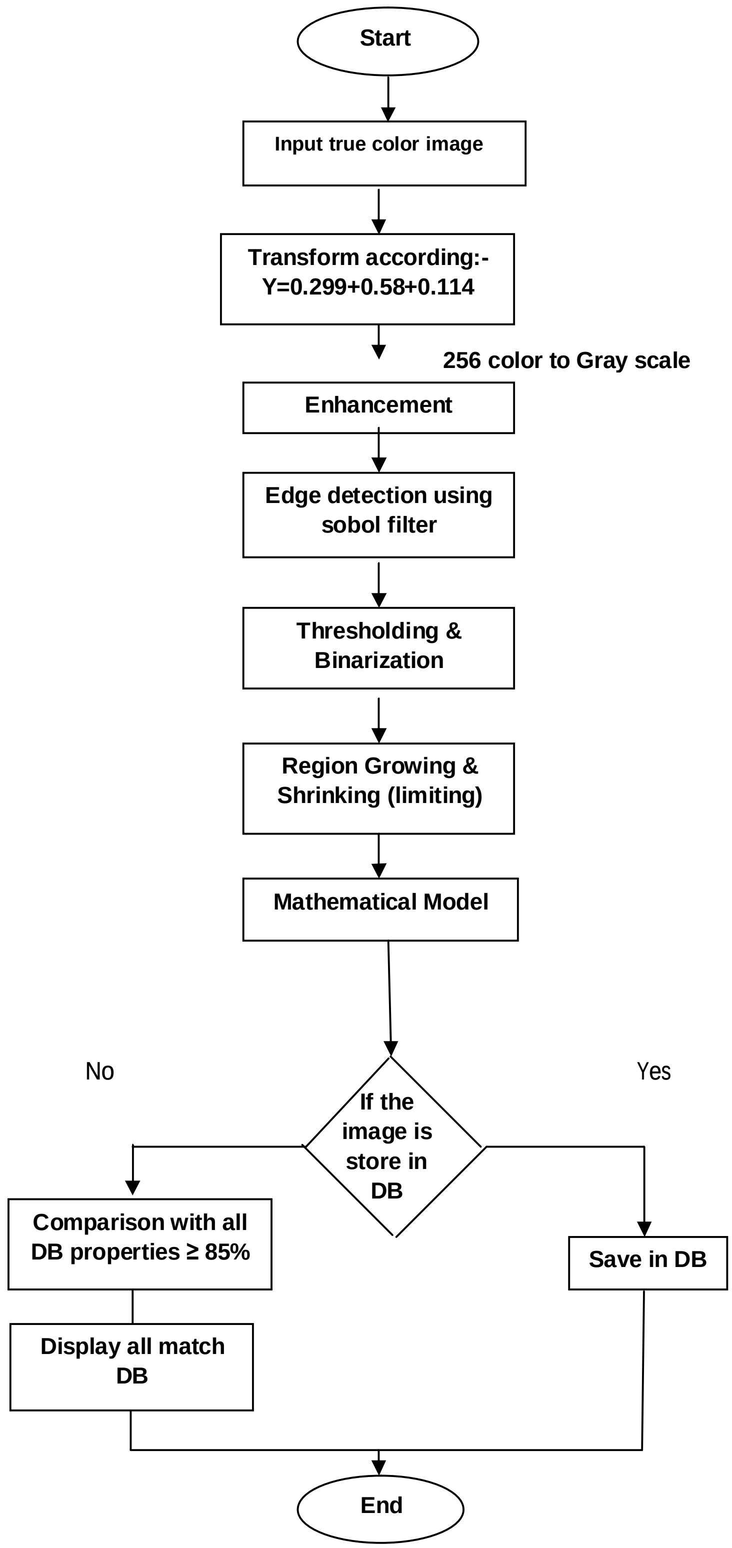

Figure (7): The block diagram of the system model

10- The Proposed System

To evaluate the performance of the proposed system, we insert the eye segment of the face image in the system shown in figure (7) and apply the previously descried methods as in the followings tests :-

Original Image:-

Figure (8): Baby 1 the original image.

First Test : - Convert the above image to gray scale

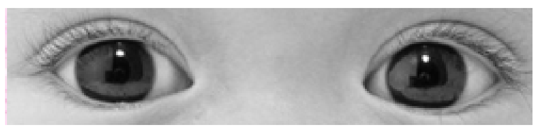

Figure (9): Baby 1 after convert to gray scale.

Second Test : - Noise removal by using smooth operation.

Figure (10): Baby 1 using smooth operation.

Third Test : - Edge detection by using Sobel filter

Figure (11): Baby 1 using sobol filter

Fourth Test: - Using Thinning algorithm

Figure (12): Baby 1 using thinning algorithm.

Fifth Test: - Region growing and shrinking algorithm.

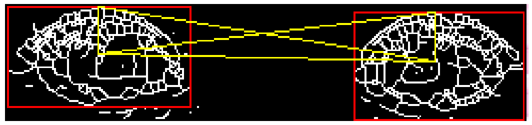

Figure (13): Baby 1 using region shrinking and growing algorithm

11- Experimental Results

In this paper, all computer programming work was done by using C++ language under window.

Note: - taking photography of the eyes should be in the front of the face and the Y-axis of the camera lens should be perpendicular on the X-axis of the distance between both eyes otherwise false results will occurs as shown below:-

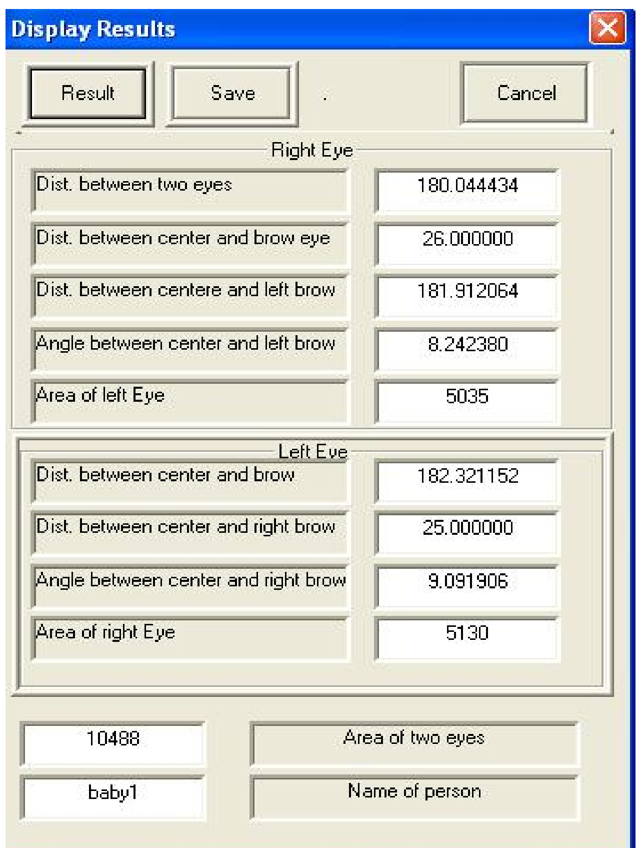

Figure (14): The experimental results of baby1 eye image segment.

So, the total experimental Result of tested eyes images is shown in the following Table:-

Table (1): The total experimental result of tested eyes images.

Image name / Properties	Baby1	Baby2	Lena	Rana	Ali
Dist. between two eyes	180.044434	121.016525	182.010986	186.024185	180.011108
Right Eye					
Dist. between center & brow eye	26.000000	21.000000	26.000000	26.000000	31.000000
Dist. between center & left brow	181.912064	122.825073	183.858643	187.832367	182.660889
Angle between center & left brow	8.24380	9.874657	8.154531	7.980875	9.801097
Area of the left eye	5035	2442	6372	7068	5832
Left Eye					
Dist. between center & brow	182.321152	122.641754	183.847763	188.403824	183.182968
Dist. between center & right brow	25.000000	18.000000	28.000000	33.000000	32.000000
Angle between center & right brow	9.091906	9.366657	8.130684	9.143966	10.710482
Area of the right eye	5130	2736	6148	6669	5865
Area of two eyes	10488	4329	9936	10912	9612

Notes:-

1- Each parameter gives about 10% of the total result which is about 85%.

2- The unit of each parameter measured in pixels.

3- The appropriate threshold use for each image is 40.

12- Conclusions

A summary of some important conclusions is presented as below:

1- The storage space for memory is very simple, about 60 bytes or less for each person. So, each parameter needs 4 bytes to store and some of these parameters need 2 bytes only. The name of each parameter needs 20 bytes and the total storage space needs 60 bytes. For example, if we want to store information about Iraqi people. The storage space will be:

$$\frac{30 millions \times 60 bytes}{1024} = 175781.25$$ **KB or 16.764 GB.**

Note: 60 bytes can be reduce to 44 bytes .

2- During this work, It was found that the improvement of the images with good clearness when the threshold is 40.

3- In case of color analysis, photos of the color of the eyes should be taken only in the day light without using artificial light.

4 - The eyes color of the individual persons could used as a tool for identification.

5 - This research is useful in many fields such as security and criminal indications.

13 - References

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تمييز الاشخاص بالاستفادة من الخصائص الهندسية للعيون باستخدام تقنيات معالجة الصور الرقمية

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كلية المنصور الجامعة

المستخلص :

في السابق كان الاعتماد على بصمات الاصابع كاساس في عمليات التمييز ولكن مع تطور العلوم والتعقيدات الحياتية كان من الضروري استخدام اجزاء اخرى من الجسم ومنها العيون موضوع البحث.

هناك عدد من الطرق لتمييز الاشخاص عن بعضهم، منها تمييز الاشخاص عن طريق بصمات الاصابع، نبرات الصوت وعن طريق صوان الاذن في هذا البحث سوف نركز على شكل العين والمسافة بينها.

لقد سبقت دراسات عديدة في هذا المجال حيث يؤخذ لون العين وقزحيتها بنظر الاعتبار لكننا في هذا البحث سنحاول ايجاد العلاقات الهندسية بين العين لكل انسان والتي تكون مختلفة من شخص الى اخر. ومحاولة ايجاد اكثر من علاقة هندسية بينهما لغرض تغطية اكثر الصفات الهندسية والعلاقة بينهما وخزنها كقاعدة بيانات لغرض مقارنتها مع ما يمكن مقارنته من الصفات.

في هذا البحث تم استخدام تقنيات قاعدة البيانات والتي تحتوي على العلاقات الهندسية للعيون من حيث المسافات والزوايا للصور الرقمية لاغراض تمييز الاشخاص. وقد تم تطبيق هذه الافكار على عدد من الاشخاص وكانت النتائج التطبيقية جيدة وواقعية بنسبة 85%.