Design and Implementation of an Iris Recognition System

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Abstract

Hough transform is still the most commonly used method in many Iris Recognition Systems (IRSs) used in large companies and airports around all over the world. However, studies implemented demonstrated that Hough transform is a time consuming method. Moreover, the algorithm should be repeated twice (adding further time consuming); one for the isolation of the iris region and the other for the pupil region through the detection of the radius and the centre of both regions.

In this paper, a new technique to isolate the iris and the pupil regions for an IRS has been proposed. This technique, by considering the centre of the iris is exactly that of the pupil, applies two new algorithms, one to find the radius and the centre of the pupil and the other to find the radius of the iris. These algorithms make use of the intensity values of the pupil and the iris areas through setting different thresholds for their isolation. The new technique is programmed using MATLAB 6.5.

The results of this study have shown that the time required to isolate the iris region and the pupil region can be reduced rapidly using this new technique. Where it requires only (3) seconds to isolate both the iris and the pupil regions on a Pentium IV PC (1.7 GHz) using this new technique. This new applied technique to isolate the iris region and the pupil region has been tested on a 100 images database, all reporting a zero failure rate.

Keywords: Iris recognition system, iris localization, pupil segmentation, personal identification, pattern recognition.

1. Introduction

Threats to information security are proliferating rapidly, placing demanding requirements on protecting tangible and intangible business and individual assets. A number of security approaches have been developed in response to the proliferating threats. These include the traditional way of security and the pattern recognition [1]. Pattern recognition is the study of how machine can observe the environment, learn to distinguish pattern of interest from their background and make sound and reasonable decision about the categories of the patterns [2].

Biometrics, as a recently as a decade ago, exists as separate entity. It is considered as an application of pattern recognition technolog. Moreover, there are many biometric technologies to suit different types of applications; one of these is the iris recognition technology [3].

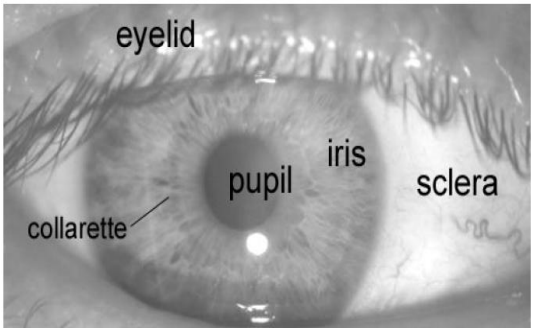


Figure (1): A Front View of the Eye

Iris recognition is an iris-based biometric include analyzing features found in the colored ring of tissue that surround the pupil of the eye. Several methods or approaches have been applied to recognize the iris. The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. A front-on view of the iris is shown in Figure (1). The iris is perforated close to its centre by a circular aperture known as the *pupil*. The iris consists of a number of layers, the lowest is the epithelium layer, which contains dense pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two iris muscles [4, 6]. The Iris recognition model consists of two stages. Each stage is of four phases. The four phases are named as *segmentation*, *normalization*, *feature extraction* and *template matching* [6]. In previous work, Masek[5] used the circular Hough transform method to detect the pupil and iris boundaries, while Abdul Ameer[3] used a new approach called *HV projection algorithm* to detect the pupil boundaries. In this paper, a new technique to isolate the iris region was proposed. This technique is based on two new algorithms. The first one is called *the modified HV projection algorithm* to find the parameters of the pupil region and the other algorithm is proposed to find the radius of the iris region.

2. Basic Principles

2.1 The Segmentation Phase

The first phase of iris recognition is to isolate the actual iris region in a digital eye image. The iris region can be approximated by two circles, one for the iris/sclera boundary and another, interior to the first, for the iris/pupil boundary [5]. Two new algorithms have been proposed to find the iris and the pupil regions, these algorithms will be examined in details later.

2.2 The Normalisation Phase

Once the iris region is successfully segmented from an eye image, the next phase is to transform the iris region so that it has fixed dimensions in order to allow comparisons. For normalisation of iris regions, a technique based on Daugman's rubber sheet model [5] was employed. The centre of the pupil was considered as the reference point, and radial vectors pass through the iris region, as shown in Figure (2). A number of data points are selected along each radial line and this is defined as the radial resolution. The number of radial lines going around the iris region is defined as the angular resolution. Since the pupil can be non-

concentric to the iris, a remapping formula is needed to rescale points depending on the angle around the circle. This is given by [5]:

$$r' = \sqrt{\alpha}\beta \pm \sqrt{\alpha\beta^2 - \alpha - r_I^2} \quad \ldots (1)$$

with

$$\alpha = o_x^2 + o_y^2$$

$$\beta = \cos\left(\pi - \arctan\left(\frac{o_y}{o_x}\right) - \theta\right)$$

where displacement of the centre of the pupil relative to the centre of the iris is given by o_x, o_y, and r' is the distance between the edge of the pupil and edge of the iris at an angle, θ around the region, and r_I is the radius of the iris. The remapping formula first gives the radius of the iris region 'doughnut' as a function of the angle θ.

In the present paper, we considered the centre of the iris is the same as the centre of the pupil, so in the implementation, the value of α in the equation above is considered to be 0 .

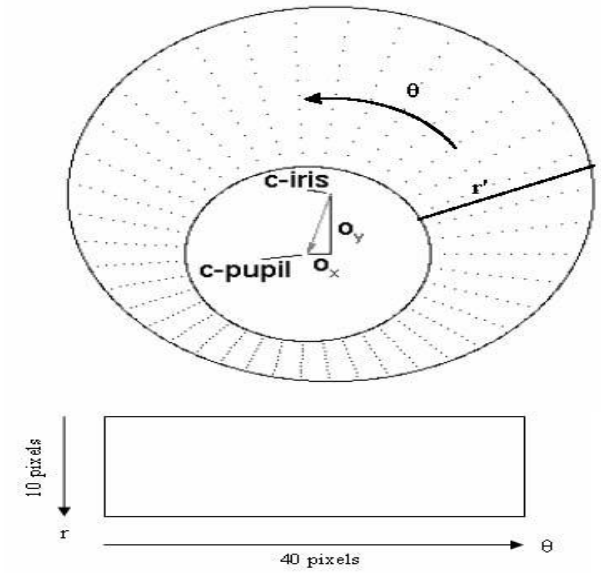


Figure (2)**:** Outline of the Normalisation Process with Radial Resolution of 10 Pixels, and Angular Resolution of 40 Pixels.

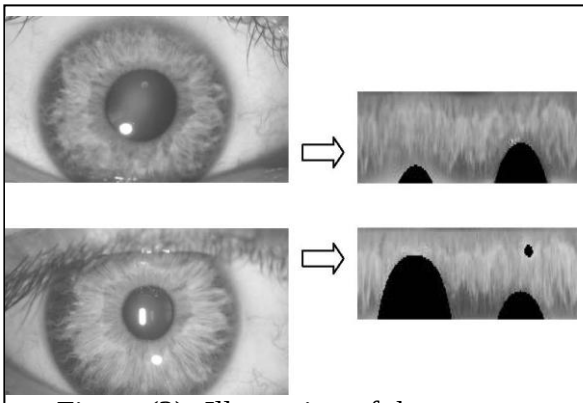


Figure (3)**:** Illustration of the Normalisation Process for Two Images of the Same Iris Taken Under Varying Conditions.

Normalisation of two eye images of the same iris is shown in Figure (3). The pupil is smaller in the bottom image, however the normalisation process is able to rescale the iris region so that it has constant dimension.

2.3 Feature Encoding Phase

In order to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted. Feature encoding was implemented by convolving the normalised iris pattern with 1D (one dimension) Log-Gabor wavelets. The 2D (two dimensions) normalised pattern is broken up into a number of 1D signals, and then these 1D signals are convolved with 1D Gabor wavelets. The rows of the 2D normalised pattern are taken as the 1D signal, each row corresponds to a circular ring on the iris region. The angular direction is taken rather than the radial one, which corresponds to columns of the normalised pattern, since maximum independence occurs in the angular direction [5].

The intensity values at known noise areas in the normalised pattern are set to the average intensity of surrounding pixels to prevent influence of noise in the output of the filtering. The output of filtering is then phase quantised to four levels using the Daugman method [7], with each filter producing two bits of data for each phasor. The output of phase quantisation is chosen to be a grey code, so that when going from one quadrant to another, only one bit changes. This will minimise the number of bits disagreeing, if say two intra-class patterns are slightly misaligned and thus will provide more accurate recognition. The feature encoding process is illustrated in Figure (4).

The encoding process produces a bitwise template containing a number of bits of information, and a corresponding noise mask which corresponds to corrupt areas within the iris pattern, and marks bits in the template as corrupt. Since the phase information will be meaningless at regions where the amplitude is zero, these regions are also marked in the noise mask. The total number of bits in the template will be the angular resolution times the radial resolution, times 2, times the number of filters used [7].

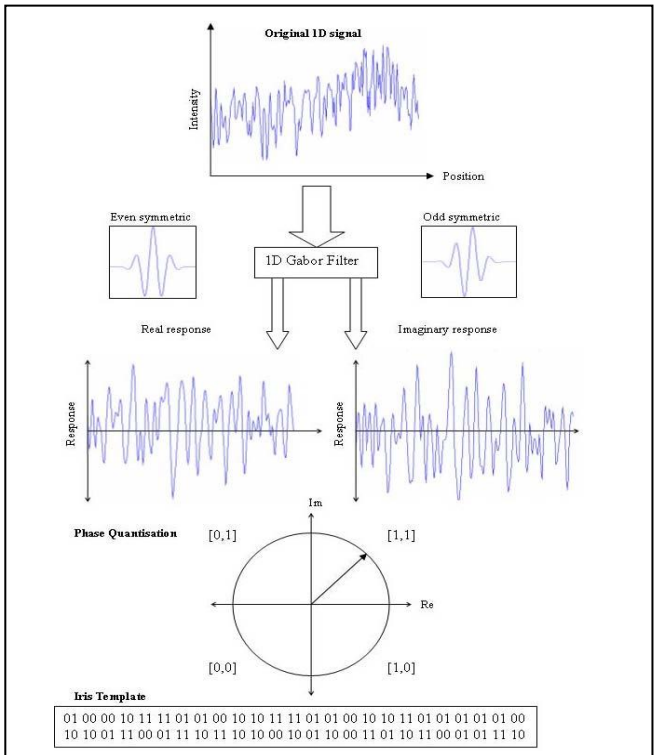


Figure (4): An Illustration of the Feature Encoding Process.

2.4 Matching Phase

For matching, the Hamming distance (HD) was chosen as a metric for recognition, since bit-wise comparisons were necessary. The Hamming distance algorithm employed also incorporates noise masking, so that only significant bits are used in calculating the Hamming distance between two iris templates. Now when taking the Hamming distance, only those bits in the iris pattern that correspond to '0' bits in noise masks of both iris patterns will be used in the calculation. The Hamming distance will be calculated using only the bits generated from the true iris region, and this modified Hamming distance formula is given as [5]:

$$HD = \frac{1}{N - \sum_{k=1}^{N} Xn_k (OR) Yn_k} \sum_{j=1}^{N} X_j (XOR) Y_j (AND) Xn_j^{`} (AND) Yn_j^{`} \quad \ldots (2)$$

where X_j and Y_j are the two bit-wise templates to compare, Xn_j and Yn_j are the corresponding noise masks for X_j and Y_j, respectively, and N is the number of bits represented by each template.

3. The Proposed Algorithms

3.1 Iris Segmentation

Most iris recognition systems use the Hough transform like Wildes et al. [8], or a variation of Hough transform like Daugman [7] to detect the parameters of the iris and the pupil region. It's been proved by implementation that this method is time consuming as it requires much time to bring out the results. In this paper, two new algorithms have been proposed to overcome the obstacles of Hough transform.

3.1.1 Pupil Isolation

The usual iris isolation technique extracts the iris region first, and that means determining the parameters of the iris region (the centre and the radius) and then extracts the pupil region. In our technique, the system starts locating the pupil region first, then considering the centre of the pupil is the centre of the iris, and then it finds the iris radius. Locating the pupil centre is the starting point of the present approach. The principle behind locating the pupil and its centre in an eye image is that the pupil is a lake of darkest pixels, and after studying the behavior of the intensity values of the pupil region we found out that the intensity values of the pupil region is ranging between 38 to 44 and sometimes in a small number of images the intensity values of the pixels in this region may reach to 85. So that, in the implementation we set a threshold ranging from (38 to 85) to indicate that the pixels having intensity values in this range are belonging to the pupil region.

The procedure to locate the pupil lake is called *the projection algorithm*. To document this procedure we introduce some terminologies:

1. Let I (x,y) be an eye image of NxM pixels. I (x,y) is the intensity of the image pixel of coordinate (x,y) ($1 \leq x \leq N$) and ($1 \leq y \leq M$).
2. Horizontal and vertical projections are defined as follows, for every x and y:
   - The horizontal projection (HP) at x is $H(x) = \sum I(x, y)$ for all y such that $1 \leq y \leq N$.
   - The vertical projection (VP) at y is $V(y) = \sum I(x, y)$ for all x such that $1 \leq y \leq M$.
   - HP is the set of horizontal projections H(x) of the image for all x's.
   - VP is the set of all vertical projections V(y) of the image for all y's.

3.1.1.1 The Proposed Modified HV Algorithm

In this scheme, we proposed a method to find the radius and the centre of the pupil. The modified HV algorithm is as follow:

1. Read an eye image.
2. Convert the eye image into black and white image by:
   - Examining the pixel at the centre of the eye image (the centre pixel), if it was less or equal than the threshold mentioned above (85), then take each pixel of the eye image and compare its intensity value with the intensity value of the centre pixel, if it is less than the value of the centre pixel it will be changed into a white pixel otherwise, it is a black pixel.
   - Otherwise, if the intensity value of the centre pixel greater than the threshold, then take each pixel of the eye image and compare its intensity value with the threshold specified above (38 to 85), if it is between these two values it will be changed into a white pixel otherwise it is a black pixel.
3. Compute the vectors HP and VP sets of projections.
4. Compute the exact pupil centre coordinates as the maximum of the vectors HP and VP by correction algorithm.
5. Compute the diameter (s) of the pupil as the average of HP-diameter and VP-diameter.

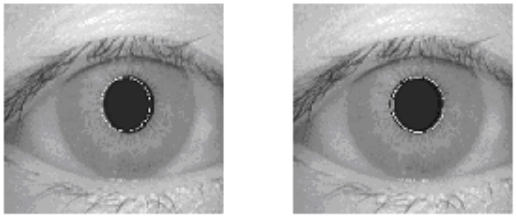
Step 4 and 5 of the algorithm are correction steps for the pupil radius. The biological fact says that the pupil is not an ideal circle. Researches and experimentations proved that some correction procedure is required [4, 6]. In this present approach, three computational procedures are implemented:

1. First count the total number of pixels contained in the pupil dark area (=A). The radius is then computed from the formula radius = $\sqrt{(A/\pi)}$. In the implementation, this is corresponding to Radius_2.
2. The second method conducted to find the radius of the pupil is by finding the summation of all the pupil pixel horizontally or vertically in one line (sum), the radius

is then computed from the formula radius = round (sum/2). In the implementation, this is corresponding to Radius_1.

Both of the methods above have been implemented in this paper, and finally the result of one of them has been taken.

3. The third procedure, uses the assumed centre, finds the two diameter end points of the horizontal projection and the two diameter end points of the vertical projection. Then it computes the average radius value of these four values. A correction shift towards right/left or towards up/down directions is done. This is shown in Figure (5).



(a) (b)

Figure (5): A Correction Shift to Pupil centre
(a) Wrong pupil centre.
(b) A better pupil centre.

The modified HV algorithm has been implemented in this paper and the results were very good comparing with the implementation of Masek [5] system. Table (1) shows some of the results applied to (10 of 756) images to find the parameters of the pupil region.

Table (1): The Results of Implementing Our New Algorithm to Find the Parameters of the Pupil Region with a Comparison of the Results of The Implementation of the Classical Way.

The Results of Implementing Our Algorithm						Classical Way Implementation		
No.	Picture	X_Pupil	Y_Pupil	Radius_1	Radius_2	X_Pupil	Y_Pupil	Radius
1	001_1_1	183	136	37	36	183	136	38
2	001_1_2	174	139	40	39	175	140	40
3	001_1_3	174	121	39	38	176	121	40
4	001_2_1	184	123	41	40	185	123	41
5	001_2_2	178	147	39	38	178	146	38
6	001_2_3	179	135	40	39	180	136	40
7	001_2_4	155	133	37	36	156	133	36
8	002_1_1	181	142	50	50	183	143	51
9	002_1_2	184	140	49	48	186	141	50
10	002_1_3	173	157	47	47	174	158	48

X_Pupil: represents the X coordinate of the circle defining the pupil.
Y_Pupil: represents the Y coordinate of the circle defining the pupil.
Radius_1, Radius_2: represent the radius of the pupil circle founded using two different methods introduced in this paper. But in the process of normalization, only one of these two radiuses has been taken.
Radius: represents the radius of the pupil circle results from the implementation of Masek system.

From this table, we can see that the results of implementing our new algorithm to find the parameters of the pupil region are almost the same of those results from the implementation of Masek system, but the difference is in the time of execution, where it takes a very short time to yield the results of the implementation of our new algorithm to each eye image, while it takes about (40 to 50) seconds to yield the same results using Masek system for each eye image.

3.1.2 The Iris Area

The next step in the current approach is to find approximately the parameters of the iris area. This approach in the current system is trying to locate the boundaries of the iris area depending on the intensity values of the iris pixels and the intensity values of the surrounding regions (sclera and pupil). In the pupil region, the intensity values of the pixels are very distinctive from the intensity values of the iris region. Depending on the database used in this paper, which it is Chinese Academy of Science – Institute of Automation (CASIA) database, the intensity values of the pupil pixels are ranging from (38 to 44) generally, making the process of finding pupil boundaries very easy, since the intensity values of the iris pixels are between (140 and 165). But in regarding to iris region, there is a difficulty in setting a threshold to filter the pixels related to the iris from the pixels related to the sclera, because by studying the intensity values of the sclera and the iris areas, both areas have almost the same intensity values, making the process of filtering the pixels related to the iris region very difficult.

To solve this problem, many assumptions have been proposed:

1. The range of radius values to search for was set manually, depending on the database used. For the CASIA database, values of the iris radius range from 90 to 150 pixels, while the pupil radius range from 28 to 75 pixels.
2. After studying the intensity values of the iris region, the intensity values of this region are ranging from (140 to 165).
3. Since both the iris area and the pupil area are circular, this approach considers the centre of the iris is the same as the centre of the pupil.
4. The new algorithm to find the radius of the iris considers the parameters of the pupil are known previously, so that (Y_Pupil, X_Pupil) represent the centre of the pupil.

3.1.2.1 The Proposed Iris_Radius Algorithm

In this scheme, we proposed a method to find the iris radius depending on the assumptions above:

1. Find the maximum intensity value in the row of the Y_Pupil and put the result in the variable J. For convenience, in the implementation, for all iris photos the row has been set to the number 172.
2. Find the number of pixels in the original eye image having the same intensity value, since CASIA database has grayscale images, this means we have 256 intensity values, from (0 to 255). The result will be a one dimensional array, each element of this array represents the times that intensity value (holding the same number of the array element location) is repeated.
3. Arrange this array in an ascending form, where the last value in the array represents the largest number of pixels having the same intensity value. The last intensity value in the arranged list (number 256) is the intensity value of the pupil area that helps us in determining the pupil/iris boundary, this means the intensity value before the last one (number 255) is the intensity value of the iris region that helps us in determining the iris/sclera boundary.
4. Find the intensity value in the location 255 and put it in the variable Val, and check it:
    - If Val is ranging from (110 to 190), then go to 5
    - Else, move down in the list and check each element until you reach to an intensity value between (110 and 190).
5. Perform many checks to Val found in step 4 to determine the threshold value (intensity value) to perform filtering according to it.
    - If (Val >= 120)&(Val<130)
      Threshold = 140
    - Elseif (Val>=130)&(Val<150)

Threshold = 155

- Elseif (Val>150)&(Val<J)

  Threshold = 165

6. Starting from the centre of the pupil, let Iris_radius_right represents the radius of the iris from the right side of the pupil, add 80 pixels to X_Pupil and put the result in the variable g and check each pixel after g if its intensity value less than Val, then increment g by one and perform the same checking again to the new value of g, else stop.
   - If the g value is in the boundaries of the image and its value less than the radius cap (the range of the iris radius that has been entered manually)

     Iris_radius_right = g – X_Pupil
   - If the Iris_radius_right value is out of the image boundaries

     Iris_radius_right = 105
   - If the Iris_radius_right value is greater than the radius cap

     Iris_radius_right = Iris_radius_right – 50
7. Repeat step 6 to the left side of the pupil centre, and put the final result in the variable Iris_radius_left.
8. Perform some checks and comparisons to the variables (Iris_radius_left, Iris_radius_right) to reach to the final approximate radius of the iris.

The Iris_Radius algorithm has been implemented in this paper and the results were very good comparing with the implementation of Masek [5] system. Table (2) shows some of the results applied to (10 of 756) images to find the radius of the iris region.

Table (2): The Results of Implementing Our Algorithm to Find the Radius of the Iris Region with a Comparison of the Results of the Implementation of the Classical Way.

No.	Picture	Iris_Radius_Classical_Way	The_New_Algorithm_Iris_Radius
1	001_1_1	100	105
2	001_1_2	100	105
3	001_1_3	102	107
4	001_2_1	100	102
5	001_2_2	105	108
6	001_2_3	105	108
7	001_2_4	102	108
8	002_1_1	82	111
9	002_1_2	112	111
10	002_1_3	112	119

Iris_Radius_Classical_Way: represents the radius of the iris found using Masek system.
The_New_Algorithm_Iris_Radius: represents the radius of the iris using our new system.

From this table, we can see that the results of implementing our new algorithm to find the radius of the iris region are almost the same of those results from the implementation of Masek system. Some times the results go far away but generally they are all acceptable. But the difference is in the time of execution, where it takes a very short time to yield the results of the implementation of our new algorithm to each eye image, while it takes about (40 to 50) seconds to yield the same results using Masek system for each eye image.

4. Experimental Results

The performance of the iris recognition system as a whole is examined. Tests were carried out to find the best results. As well as confirming that the system provides accurate

recognition, experiments were also conducted in order to confirm the uniqueness of human iris patterns by deducing the number of degrees of freedom present in the iris template representation, as well as, experiments were also conducted to recognize the individuals.

There are a number of parameters in the iris recognition system, and optimum values for these parameters were required in order to provide the best recognition rate. These parameters include; the radial and angular resolution, r and θ, respectively, which give the number of data points for encoding each template, and the filter parameters for feature encoding [5]. The filter parameters include, the number of filters, N, their base wavelength λ_n, filter bandwidths given by σ/f, and the multiplicative factor between centre wavelengths of successive filters given by α. Our system were programmed using MATLAB version 6.5 on a Pentium IV PC (1.7 GHz).

The database used in this paper is the CASIA eye image database [9] contains 756 greyscale eye images with 108 unique eyes or classes and 7 different images of each unique eye. Images from each class are taken from two sessions with one month interval between sessions. The images were captured especially for iris recognition research using specialised digital optics developed by the National Laboratory of Pattern Recognition, China. The eye images are mainly from persons of Asian decent, whose eyes are characterised by irises that are densely pigmented, and with dark eyelashes. All eye images of CASIA database have the same dimensions with 320 pixels rows and 280 pixels columns. The format of iris pictures addresses is as follow:

00n_m_k

00n: represents the sequence of the person.
m: represents the left (1) or the right (2) eye.
k: represents the sequence of the image captured to that person for his left or right eye.

For example, the eye image (002_1_3) means the third image of the left eye for the second person. For testing the system, we used two data sets for comparisons to test for the uniqueness of iris patterns. The first data set is called *Set_1* contains '79' images from CASIA database, and the second data set is called *Set_2* contains '50' images from CASIA database.

4.1 Uniqueness of Iris Patterns

The first test was to confirm the uniqueness of iris patterns. Uniqueness was determined by comparing templates generated from different eyes to each other, and examining the distribution of Hamming distance values produced. This distribution is known as *the inter-class distribution*.

According to statistical theory, the mean Hamming distance for comparisons between inter-class iris templates will be 0.5. This is because, if truly independent, the bits in each template can be thought of as being randomly set, so there is a 50% chance of being set to 0 and a 50% chance of being set to 1. Therefore, half of the bits will agree between two templates, and half will disagree, resulting in a Hamming distance of 0.5. The templates are shifted left and right to account for rotational inconsistencies in the eye image, and the lowest Hamming distance is taken as the actual Hamming distance. Uniqueness was also be determined by measuring the number of degree of freedom represented by the templates. This gives a measure of the complexity of iris patterns, and can be calculated by approximating the collection of inter-class Hamming distance values as a binomial distribution. The number of degree of freedom, *DOF*, can be calculated by [5]:

$$DOF = \frac{p(1-p)}{\sigma^2} \quad \ldots (3)$$

where p is the mean, and σ is the standard deviation of the distribution. Table (3) shows some of the results of implementing (10 of 172) different comparisons between different eye images.

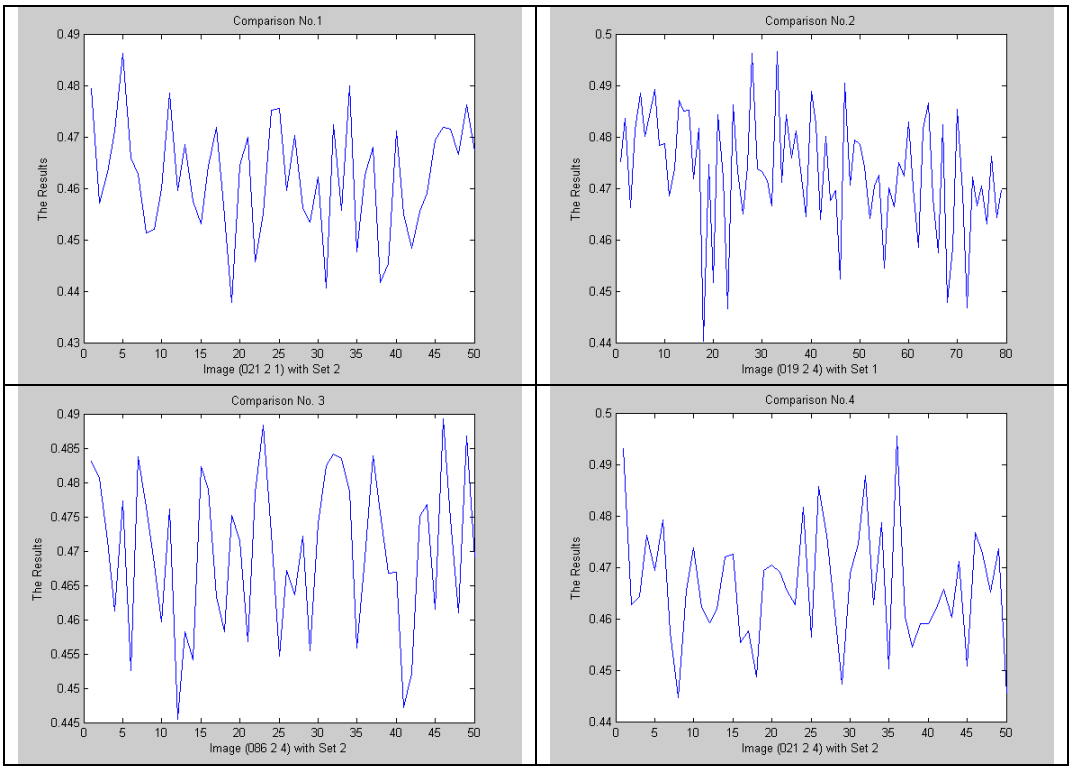
Table (3): The Results of Comparing Different Eye Images with Set_1 and Set_2 of Eye Images (Inter-Class Comparisons).

No.	Comparison	p	σ	*DOF*
1	021_2_1 with Set_2	0.4623	0.011	2022
2	019_2_4 with Set_1	0.4733	0.0115	1896
3	086_2_4 with Set_2	0.47	0.0114	1896
4	021_2_4 with Set_2	0.4664	0.0115	1855
5	027_2_1 with Set_2	0.4672	0.0118	1774
6	095_2_3 with Set_1	0.4725	0.0119	1771
7	085_1_2 with Set_2	0.4658	0.012	1715
8	024_2_1 with Set_1	0.4719	0.0124	1614
9	069_2_1 with Set_2	0.472	0.0124	1606
10	102_1_1 with Set_2	0.4795	0.0127	1532

From this table, we can see that the minimum mean is 0.46 and the maximum mean is 0.47, so that these results conform to the theory of statistical independence, since the mean of the distribution is almost 0.5 for all comparisons that have been tested.

In regard to the uniqueness of iris patterns using *DOF*, from this table, we can see that *DOF* for these comparisons is very high. For example, comparison number 1 between image 021_2_1 with Set_2 yields a *DOF* of 2022, that means the patterns of the iris region for these images are very unique.

Below, the graphs that represent the implementation of the comparisons of Table (3).



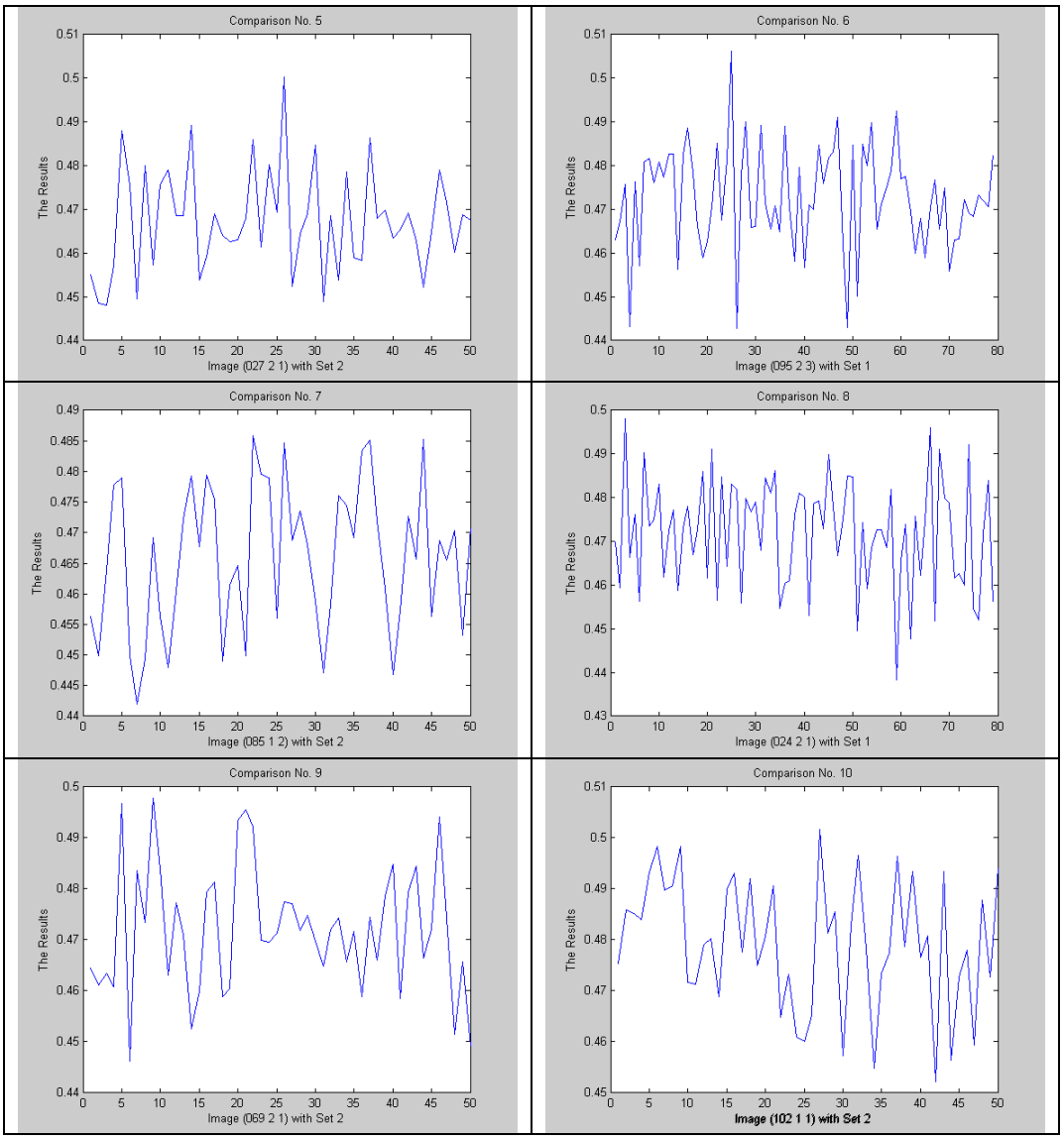


Figure (6): The Graphs that Represents the Results of Table (3).

The text on the bottom of each graph represents the address of the image that the comparison has been made between it and Set_1 or Set_2 data sets. The text on the left of each graph represents the result (mean) of each comparison that has been made between a specific image and Set_1 or Set_2 data sets. For example, the last comparison, comparison number 10 between image (102_1_1) and Set_2, each result on the left of the graph of this comparison represents the result of implementing the comparison between this image and each image of Set_2 data set. The text on the top of each graph represents the number of the comparison.

4.2 Recognition of Individuals

When a comparison between two different iris images is made, the distribution of hamming distance is called *the inter-class hamming distance distribution*, if the comparison is made between two iris images belonging to the same person this is called *the intra-class hamming distance distribution*, as shown in Table (4).

Table (4): The HD of Comparing Eye Images Belonging to the Same Person (Intra-Class Comparisons).

No.	Image 1	Image 2	Masek HD	Our HD
1	001_1_1	001_1_2	0.4401	0.4366
2	001_1_1	001_1_3	0.3292	0.3007
3	001_1_2	001_1_3	0.444	0.438
4	001_2_1	001_2_2	0.4569	0.4484
5	001_2_1	001_2_3	0.4642	0.46512
6	001_2_1	001_2_4	0.4683	0.5
7	001_2_2	001_2_3	0.4183	0.42654
8	001_2_2	001_2_4	0.443	0.44214
9	001_2_3	001_2_4	0.48	0.45644
10	002_1_1	002_1_2	0.4318	0.24568

From this table, we can see that the results of our implementation are almost similar to those of Masek implementation.

4.3 The Parameters Used in the Implementation of the System

The optimum encoding of iris features was with one 1D Log-Gabor filter with a bandwidth given by a σ / f of 0.5. The centre wavelength of this filter for both the data sets used (Set_1 and Set_2) was found to be 18 pixels. An optimum template size with radial resolution of 20 pixels, and angular resolution of 240 pixels was chosen for both data sets. These parameters generate a biometric template that contains 9600 bits information. In order to correct for rotational inconsistencies 8 shifts left and right were required for both data sets.

5. Conclusions

The first conclusion to be noticed is that using the biometric technologies to achieve the security in the airports, ports and companies proved to be very successful and secure over the traditional security methods, because the biometric technologies are associated with a user so that they can not be lent or stolen, beside this, the biometric technologies are not prone to dictionary or brute force attacks because biometric authentication requires the physical presence of the user, as well as, by using the biometric technologies, each person will have only a single identity, preventing him from issuing multiple identities and this advantage will help in the screening applications.

The second conclusion is that there are no actual features in an iris that are to be extracted and used at later stages as references for classification decision. The third conclusion is that directional edge detection, such as, Canny and Hough are almost essential in every IRS reported in literatures. What has been done and reported in this paper is the use of new algorithm, named *HV projections*, for iris isolation. The iris isolation of the current work has been achieved in two steps. The first uses HV projection to isolate the pupil area and then depending on the centre of pupil the radius of the iris is calculated using the new algorithm to find the radius of the iris. Both of these algorithms showed very good results and these results compared with the implementation of Masek System [5] and they were almost the same, but with short execution time as shown in Table (1) and (2).

After the isolated part of the iris has been determined, it has been mapped into a rectangular and normalized form to get the iris in cartesian coordinate. The iris has been convoluted for enhancement and presentation of the unknown features. We select Log-Gabor filter for this convolution mechanism as it is the easiest filter that can modulate the iris pixels with sine and cosine frequencies. It has the power of Gabor (Gaussian modulated with sine/cosine) but simple in implementation. This enables the system to code the iris as complex (pairs of coordinates) plane.

Matching has been achieved for both inter-class and intra-class hamming distance and the results were very good and showed that the patterns of the iris are highly freedom which means that there are no two irises have the same features, as shown in Table (3), and recognizing the individuals is possible using the new technique proposed in this paper, as shown in Table (4).

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تصميم وتنفيذ نظام لتمييز قزحية العين

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المستخلص

لايزال تحويل هوف الطريقة الاكثر استخداماً في أنظمة تمييز قزحية العين المستخدمة في الشركات الكبرى والمطارات في جميع انحاء العالم. مع ذلك, الدراسات التي اجريت اوضحت ان تحويل هوف يستهلك وقت طويل في التنفيذ. اضافة لذلك, فان خوارزمية هوف يجب ان تكرر مرتين (مما يعني استهلاك وقت اضافي), وقت لعزل منطقة القزحية ووقت اضافي آخر لمنطقة البؤبؤ من خلال استخراج نصف القطر والمركز لكليهما.

في هذه البحث, تم اقتراح تقنية جديدة لعزل منطقة البؤبؤ والقزحية لنظام تمييز قزحية العين. هذه التقنية, بافتراض ان مركز القزحية في العين هو نفسه مركز البؤبؤ, تستخدم خوازميتين, واحدة لمعرفة مركز ونصف قطر البؤبؤ والأخرى لمعرفة نصف قطر القزحية. تستفيد هذه التقنية من اختلاف قيم الإضاءة في خلايا صورة العين لمنطقتي البؤبؤ والقزحية وذلك من خلال وضع عتبات مختلفة لعزلهما. هذه التقنية الجديدة تم تنفيذها باستخدام برنامج Matlab 6.5.

نتائج هذه الدراسة اظهرت ان الزمن اللازم لعزل منطقتي البؤبؤ والقزحية من الممكن ان يقلل بصورة كبيرة باستخدام هذه التقنية الجديدة. حيث ان التقنية الجديدة تحتاج الى (3) ثواني فقط لعزل كلاً من منطقتي البؤبؤ والقزحية. باستخدام المعالج (Pentium IV) ذو السرعة (1.7 GHz).

هذه التقنية الجديدة المطبقة عملياً لعزل منطقتي البؤبؤ والقزحية في العين تم اختبارها على قاعدة بيانات مؤلفة من 100 صورة, كل النتائج أظهرت ان معدل الفشل كان صفر لهذه الاختبارات.

كلمات البحث الرئيسية: نظام تمييز قزحية العين, تحديد منطقة القزحية, تقطيع منطقة البؤبؤ, التعرف على الاشخاص, تمييز الانماط.