# The Similarity of The Parts of Iris Texture

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***Abstract*— In the proposed search, new technique for calculating the similarity among parts related to iris images for the selected person and among iris images will be suggested by dividing iris texture into pre decided number of parts and calculating some features of each one of these parts as a texture then calculating degree of similarity among specific part and all other parts of the same iris and with some irises in database according to some accepted rules. The proposed method divided iris texture into eight parts with (45 degrees) for each part, the features of GLCM algorithm will be calculated for parts of iris image then the distance or similarity between specific and required iris with other irises that will be stored in database will be calculated and finally, the similarity calculated between each part (with 45 degrees) of iris and parts of irises stored in database. The proposed system applied some suitable techniques for localized the pupil of the iris image by using watershed segmentation method by drawing arrows between each pixels and 8-nighbouring pixels according to occurrence of some suitable feature then deleting all arrows from selected pixels if another feature doesn't available in this pixels, this proposed system used for reducing database size for each registered person depending on extracted features from some parts of another person or from extracted features from one part of iris image.**

***Keywords*— Pupil, Similarity, Iris, Watershed, GLCM.**

## I. INTRODUCTION

Persons Recognition depending on Biometrics is one suitable, reliable and promising ways for discovering specific person or individual among either knowing or unrestricted group of persons. A biometric system recognizes a desired person by using suitable and defined specific physiological features that doesn't change related to age, work, disease and wishing for example palm prints, fingerprints, hand geometry, iris, face and retina. Some another biometrics indicators include behaviour features such as speech, gait, and signature which may be changed depending on wishing of interesting persons[1].

Biometrics systems depend on iris texture exploit and related to some suitable textural properties on the desired iris of a selected person and these features will be shown independent among persons even among irises of identical twins rather than irises of the same person. Therefore, automated system of iris biometrics recognition can distinguish between any two different persons even between identical twins [2]. Iris can be defined as an internal feature of human body and it is protected very well. In human, iris forms in the early period of development and this organ totally formed during first 8-th months of person life [3], the patterns of any human iris are unrelated and random so, no expected effects from the genetic features in building operation of the design and structure of the pattern of it, therefore there is no different persons have identical pattern of this biometrics feature. According to reliable studies there are no iris patterns identical even of both irises of same individual or either for identical twins as well[1].

A typical iris system for recognition persons generally has three stages:

(a) localization of the iris image
(b) extraction of desired features and,
(c) calculating distance and performing matching technique. [4] [5].

Each indicator of the biometric has the following properties [6]

1- Universality: available in all peoples.
2- Uniqueness: It is unique for any person compared to any other person.
3- Permanence: stable over time.
4- Collectability: easy for capturing.
5- Performance: allowing distinguish any person with accepted accuracy.
6- Acceptability: accepted for showing and dealing by the users.
7- Circumvention: the fault degree must be very low.

Each one of the biometrics has its special degree of above properties so person select biometric according to its desired degree of accuracy[1]. One of the most important processes of any biometric system is the enrolment or registration process by making sure that the person, who is going to be registered, is the desired person as shown in fig.(1). Systems can be divided into :

1- one-to-one (1: 1) systems by matching an input image with a previously known and stored

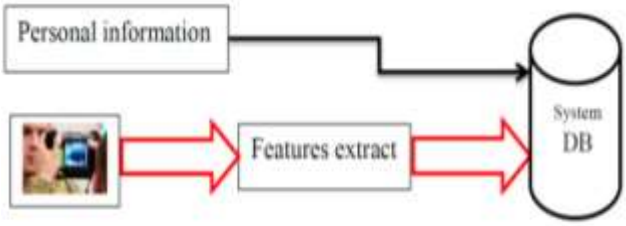


Fig. 1 Registration process

image as shown in fig. (2)

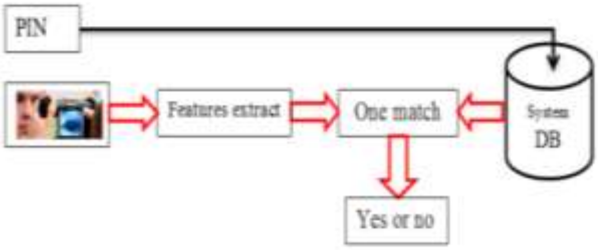


Fig.2 Verification system

2- one-to-many (1: N) system, this search produces a candidate list based on a score for the matching process, as illustrated in fig. (3).

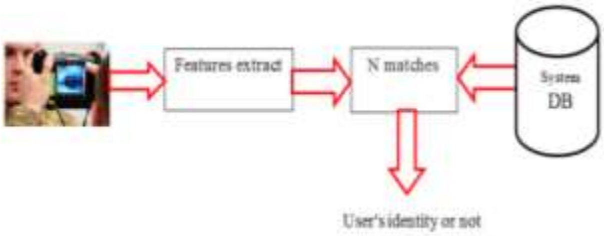


Fig.3 Identification system

There are many open problems in systems of iris as a biometrics. One group of such problems is related to contact lenses because it effects on iris system performance as illustrated in fig.(4) [7].

Fig.4 Effect of contact lenses

also, another problem is the different damaged effects that produced after some biological or medical causes as illustrated in fig. (5) [1].

Fig.5 Effects of biological causes

## II. Related Work

Researchers in [8] proposed a technique that discussed in detail , they mentioned that the system of iris recognition is best human identification system depending biometrics and Daugman's method for recognition human iris considered as the efficient & accurate iris recognition system as previous biometrics system and the search used CASIA Database and perform operations such as Histogram Equalization, binerization, Feature Extraction, normalization and some other suggested operations in specific way, the performance of experimental work of Iris recognition system they got false accept rate as 0%., False Reject Rate as a 1.04% and True Accept Rate as a 98.96%.

Sr. Sahaya Mary James in [9] proposed the usage of famous Daugman’s algorithm for perfect identification method, the proposed system consist of four stages that start by performing Gaussian filter, finding center and radius of the pupil , defined iris boundary and finally Calculating the circle gradient, they thought that the important stage in the proposed system is to find out the gradient value for finding iris and pupil boundaries, This study also suggests method of avoiding noise effect.

Tania Johar and Pooja Kaushik in [10] said that the biometric systems such as iris, face recognition, and fingerprint are used for identification and verification for secure purposes and most new systems used Daugman algorithm. they suggest declared system for applying segmentation for iris image as well as normalization process by using Hough Transforms and Daugman’s Model for Rubber Sheet in normalization specific image.

Tossy Thomas, et.al. in [11] introduced an accurate system called Random Sample Consensus (RANSAC) for identifying ellipse for iris boundaries if it has non-circular shape. they locate boundaries of iris best than other methods by using special transform (Hough), also they used famous method (Daugman) for performing normalization process .

Sasa Adamovic , et. al. in [12] presented a perfect analysis of iris images with for the purpose of developing optimized cryptosystems depending on biometrics, by calculating local value of entropy and the probability of mutual information by identifying regions of the iris correctly for the desired purposes. Structure for developing extraction process of the truly random sequences from iris biometrics, they used wavelet domain as a transform domain.

## III. Proposed Method

The proposed method consists of many processes as follow

- perform segmentation method like Watershed algorithm.
- iris Pupil detection of desired image.

- Normalization of selected iris image.
- Detection (ROI) to calculate desired features from iris region.
- Divided ROI to 8- parts with $45^o$ for each part.
- Calculate important features for each part.
- Calculate the maximum similarity among specific part and other parts of iris parts that stored in database.

The proposed block diagram of the suggested system can be illustrated in fig.(6)

*A. Image Normalization*

For different variations in light effect and contrast in the iris images, the process of normalization in the gray level pixels for proving the wanted quality of information in the iris image will be suggested and performed. Image (N) after applying normalization process will be discovered by applying normalized equation (1) for entering image (I):

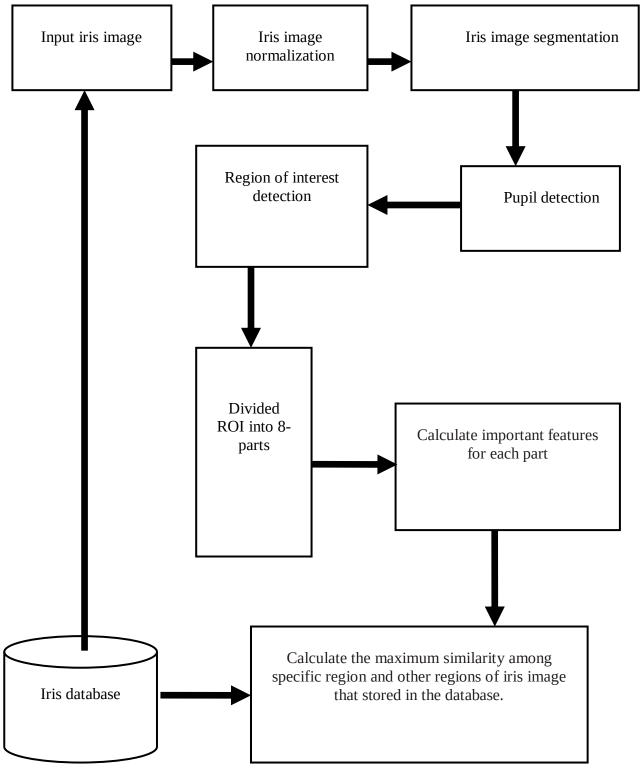


Fig.6 Block diagram for the suggested system

$$N(i,j) = \begin{cases} M_o + \sqrt{\frac{V_o (I(i,j)-M)^2}{V}} & \text{if } I(i,j) > M \\ M_o - \sqrt{\frac{V_o (I(i,j)-M)^2}{V}} & \text{otherwise} \end{cases} \quad \ldots(1)$$

Where, M represent the mean and V represent the variance of original image I (i, j) of the iris, Mo is wanted mean and Vo represent the wanted variance for the output image N(i, j) [13].

*B. Performing watershed segmentation*

Watershed segmentation algorithms can be clustered into many groups, the first one depends on techniques for simulating flooding process by raising water level in virtual 3-D image (x-direction for horizontal position, y-direction for vertical position, z-direction that represent color of the pixel) ; the other group aims to speedy and direct finding of the wanted watershed pixels that represent objects boundaries in the image [14] as explained in fig.(7).

For the purpose of applying watershed method for segmentation of iris images with suitable technique from the second group, the following operations must be performed

1- Preprocessing step by minimizing number of colors in the iris image to minimize the bad effects of over segmentation process that produce bad results for the boundaries of the objects in the image.

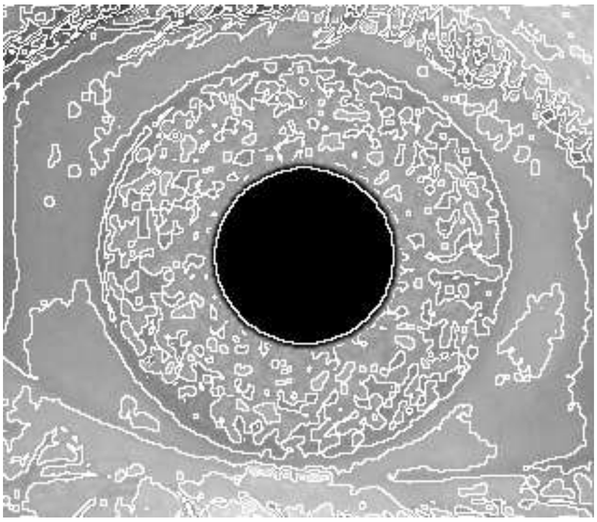

Fig.7 watershed segmentation

2- For 8-neighboring pixels related to each pixel in the image an arrow will be drawn from any neighborhood to the pixel with color value less than color level of its neighborhood.

3- Any point received more than two arrows from its connected pixels may be flooded by suppressed all arrows entering and leaving to this pixel with more than two received arrows[6].

4- This algorithm produced local watershed lines, where the reminder arrows in the pixels represent the true divide lines which can be extracted simply easily.

5- Labeling all connected points in each closed region with suitable number that represent segment number for each connected pixels, these process can be applied by giving the same labeling number for a pixel and its neighborhoods then the neighborhoods of neighborhood and so on until last pixel of the closed region.

*C. Pupil Detection*

The pupil region will be discovered by exploiting some desired and selected features related to the pupil area as follows

a- pupil region is darker region than other regions in the image with small value of gray levels for all pixels in the region so the mean of each segment can be checked for selecting suitable segments with smallest mean value.

b- the ratio between the perimeter of the pupil segment to the area of this segment is minimum among all proposed segments as a pupil segment.

c- The number of pixels in pupil segment can be predicted for each data base images as illustrated in fig.(8).

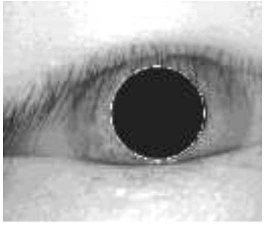

Fig.8 Detection of pupil region

*D. ROI detection*

The ROI detected after the process of pupil discovering step and the radius of pupil calculated then the desired radius of iris segment will be discovered by adding (50) pixels to the radius of the pupil as illustrated in equation (2) and fig.(9)

$$Radius_{roi}=Radius_{pupil}+50 \quad \dots (2)$$

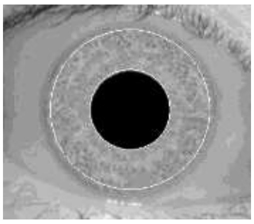

Fig.9 ROI detection

*E. Dividing ROI*

Then, the ROI will be divided into 8- regions with (45 degrees) for each region, see fig.(10). the center of pupil region is p (xp, yp) and the radius of pupil region is (r) then

1- Any point becomes in ROI if the calculated distance between it and center point is greater than radius (r) until (50 + r).
2- Any point belongs to first part if $(\tan^{-1}((j-y_p)/(i-x_p)))$ between (0-45).

*F.GLCM features*

The Co-occurrence matrix of gray level image (GLCM) is a method for finding statistical features for specific texture in specific image , sub-image or segment and this method used in some important applications. (GLCM) is a two dimension matrix with same number of columns and rows and this number equal to the founded number of colours in the input image, the position or element P (i , j |d,Θ) in the constructed array consist of the probability values for variations between pixels values (i and j) with desired distance (d) and angle (Θ) [15].

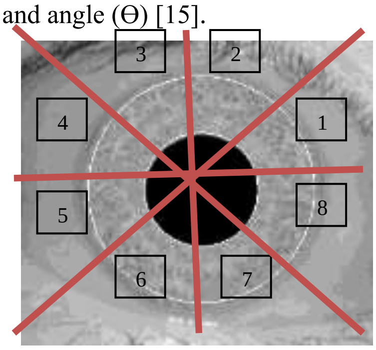


Fig.10 Eight parts for region of interest

To explain the process of finding GLCM matrix, an array of (5×5) that represent sub-image has (3) colors as illustrated in fig.(11).

| image | | | | |
|---|---|---|---|---|
| 0 | 1 | 1 | 2 | 1 |
| 0 | 0 | 2 | 2 | 2 |
| 0 | 1 | 2 | 2 | 0 |
| 1 | 2 | 0 | 2 | 2 |
| 2 | 2 | 1 | 1 | 0 |

| | P(i,j;1,0) | | |
|---|---|---|---|
| j \ i | 0 | 1 | 2 |
| 0 | 1 | 2 | 2 |
| 1 | 1 | 2 | 3 |
| 2 | 2 | 2 | 5 |

| | P(i,j;1,45) | | |
|---|---|---|---|
| j \ i | 0 | 1 | 2 |
| 0 | 1 | 2 | 1 |
| 1 | 0 | 1 | 3 |
| 2 | 2 | 1 | 4 |

| | P(i,j;1,90) | | |
|---|---|---|---|
| j \ i | 0 | 1 | 2 |
| 0 | 2 | 1 | 3 |
| 1 | 3 | 0 | 1 |
| 2 | 1 | 4 | 5 |

Fig.11 Calculating GLCM matrix

Number of features can be discovered by using GLCM:

1- <u>ASM (Angular second moment):</u> represent the degree of homogeneity in specific image or segment

$$ASM = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\{P(i,j)\}^2 \quad \dots (3)$$

2- <u>Contrast: represent the degree of local variation in pixels intensity</u>

$$Contrast = \sum_{i=0}^{G-1} n^2\{\sum_{i=1}^{G}\sum_{j=1}^{G} P(i,j)\} \quad \dots (4)$$

Where, |i-j|=n

3- <u>IDM (Inverse difference moment): represent Local homogeneity degree in specific array or image.</u>

$$IDM = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\frac{1}{1+(i-j)^2}P(i,j) \quad \dots (5)$$

4- <u>Image Entropy:</u>

$$Entropy = -\sum_{i=0}^{G-1}\sum_{j=0}^{G-1} P(i,j)\times\log(P(i,j)) \quad \dots (6)$$

5- <u>Image Correlation: represent the linear relation between points at relative positions each to other.</u>

$$Correlation = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\frac{\{i\times j\}\times P(i,j)-\{\mu_x\times\mu_y\}}{\sigma_x\times\sigma_y} \quad \dots (7)$$

6- <u>Image Variance: represent the degree of difference compared to the mean of image.</u>

$$Variance = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}(i-\mu)^2 P(i,j) \quad \dots (8)$$

7- <u>Sum Average:</u>

$$Aver = \sum_{i=0}^{2G-2} iP_{x+y}(i) \quad \dots (9)$$

8- <u>Sum Entropy:</u>

$$Sent = -\sum_{i=0}^{2G-2} P_{x+y}(i)\log(P_{x+y}(i)) \quad \dots (10)$$

9- <u>Difference Entropy:</u>

$$Dent = -\sum_{i=0}^{G-1} P_{x-y}(i)\log(P_{x-y}(i)) \quad \dots (11)$$

10-<u>Inertia:</u>

$$Inertia = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\{i-j\}^2\times P(i,j) \quad \dots (12)$$

11-<u>Cluster Sade:</u>

$$Shade = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\{i+j-\mu_x-\mu_y\}^3\times P(i,j) \quad \dots (13)$$

12-<u>Cluster Prominence:</u>

$$Prom = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\{i+j-\mu_x-\mu_y\}^4\times P(i,j) \quad \dots (14)$$

Where

G represent number of GLs in the image.

$\mu$ represent the mean of image.

$\sigma$ represent standard deviations of image.

$$P_x(i) = \sum_{j=0}^{G-1} P(i,j)$$

$$P_y(i) = \sum_{i=0}^{G-1} P(i,j)$$

$$\mu_x = \sum_{i=0}^{G-1} i\sum_{j=0}^{G-1} P(i,j) = \sum_{i=0}^{G-1} iP_x(i)$$

$$\mu_y = \sum_{i=0}^{G-1} j\sum_{j=0}^{G-1} P(i,j) = \sum_{j=0}^{G-1} jP_y(j)$$

$$\sigma_x^2 = \sum_{i=0}^{G-1}(i-\mu_x)^2\sum_{j=0}^{G-1} P(i,j) = \sum_{i=0}^{G-1}(P_x(i)-\mu_x(i))^2$$

$$\sigma_y^2 = \sum_{i=0}^{G-1}(i-\mu_y)^2\sum_{j=0}^{G-1} P(i,j) = \sum_{i=0}^{G-1}(P_y(i)-\mu_y(i))^2$$

$P_{x+y}(k) = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1} P(i,j) \quad Where\ i + j = k$

$P_{x-y}(k) = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1} P(i,j) \quad Where\ |i + j| = k$

[15] [16].

*G. The similarity*

The calculated values of features will be normalized to expected values between (0-1) by applying equation (15) [17].

$F_{norm}=(f_p-f_{min})/(f_{max}-f_{min})$ … (15)

The calculated distance represent a famous type of measuring distance (Euclidean) and it is faster method compared to some other metrics. Normalized effect of each feature written as

*Dm=1/( features no.) *(f1-f1')* … (16)

Value of similarity =1-Dm

## IV. Results

When the suggested system performed the results can be shown as follow

TABLE I
RESULTS OF IMAGE (18)

| part | Input iris | score | Similar image | part |
|---|---|---|---|---|
| 1 | 13.BMP | 95 | 21.BMP | 1 |
| 2 | 13.BMP | 91 | 21.BMP | 2 |
| 3 | 13.BMP | 94 | 21.BMP | 3 |
| 4 | 13.BMP | 94 | 21.BMP | 4 |
| 5 | 13.BMP | 98 | 15.BMP | 5 |
| 6 | 13.BMP | 91 | 21.BMP | 6 |
| 7 | 13.BMP | 96 | 17.BMP | 7 |
| 8 | 13.BMP | 98 | 17.BMP | 8 |

## V. Conclusions

1- Image 18.bmp in result (1) not similar completely with any complete image in iris data-base but the eight parts of image 18.bmp have similar parts in other images in iris database.

TABLE II
RESULTS OF IMAGE (13)

| part | Input iris | score | Similar image | part |
|---|---|---|---|---|
| 1 | 18.BMP | 96 | 21.BMP | 1 |
| 2 | 18.BMP | 98 | 17.BMP | 2 |
| 3 | 18.BMP | 93 | 7.BMP | 6 |
| 4 | 18.BMP | 87 | 3.BMP | 4 |
| 5 | 18.BMP | 93 | 7.BMP | 5 |
| 6 | 18.BMP | 98 | 2.BMP | 8 |
| 7 | 18.BMP | 95 | 16.BMP | 5 |
| 8 | 18.BMP | 97 | 21.BMP | 7 |

2- result (2) clarified image (13.bmp) considered similar to image (21.bmp) because four parts of these images are similar as shown so, these images belong to same person so the similarity between them is 92%, as explained in Fig.(12).

3- The data base image can be reduced by saving number of referenced iris image and each other images in data base can be divided into suitable parts related to the similar parts in other iris images.

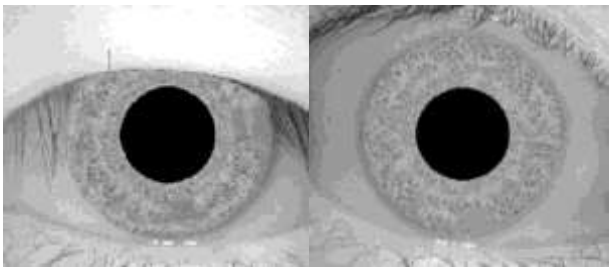

Fig.12 Images 13 and 21

4- This technique will be used in examining similarity between image parts for brothers and identical twins to discover partial relation between these irises.

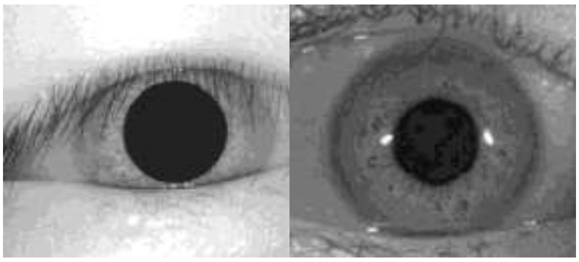

Fig.13 Problems in iris images

5- Suggested method allows avoiding hard handle process of the noisy regions like eyelash, eyelid,…. so the results of comparing related irises cab be more and more accurate by avoiding regions with parts from another bodies in the iris image as illustrated in fig. (13).

6- The GLCM matrix can be designed for part or segment of an image by taking in account desired region with virtual surrounding region with value of (-1) for all pixels to avoid the unwanted effects of this region on the results of GLCM algorithm as illustrated in fig. (14).

Fig.14 Selected segment with surrounding region

the circular region of interest can be translated to rectangular region by translating iris region from polar coordinates to cartesian coordinates but this operation related to the number of pixels in surrounding circle related to each selected radius from (r) to the (r + 50) which are between ($2\pi r$) to ($2\pi(r + 50)$) and these value if greater than (360) some of the pixels will be deleted and if less than (360) some pixels will be repeated and this operation produce inaccurate or imperfect results because of different interpolation operations used for each radius.

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