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Research Article

Iris Recognitions Identification and Verification using Hybrid Techniques

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Abstract: The aim of this study is proposed a new IRS using hybrid methods. These methods used to extract features of tested eye images. Gabor wavelet and Zernike moment used to extract features of iris. Canny edge detection and Hough transform used to determine the iris. The proposed system tested on CASIA-v4.0 interval database. The results show that the proposed method having good accuracy about 97%. PSNR applied on the training and testing iris image to measure the simmilarity between them. PSNR is support the proposed system where, highest value of PSNR for the tesed image dells with the image is belong to the same person in training database.

Keywords: Biometric, features extraction, Gabor wavelet, iris recognition, Zernike moment and hybrid

INTRODUCTION

Biometric systems are one from the common and accurate systems that used in the identification process of persons. Now the important system that uses in the security domain is iris system. Where this system is the best biometric technique. Inside the global and records protection domains, biometrics play a vital position. The using of diverse physiological characteristics of the human. Such of these characteristics are a face, ear, hand geometry, fingerprint, DNA, iris, etc. Every man or woman the biometrics accurately identifies and distinguishes one from another (Abiyev and Altunkaya, 2008).

Any human physiological and/or behavioral feature is used as a biometric perform as protracted because of it satisfies the next requirements. These requirements are:

- Universality (U): Mean each person should be own characteristic.
- Distinctiveness (D): Mean each person should be differentiable characteristic between each other.
- Permanence (P): Mean the characteristic of each person must fix and not change with time.
- Collectibility (Co): Mean each person should have the quantitative characteristic to allow to measure.
- Acceptability (A): Mean the quantitative characteristic has great acceptance between the societies.
- Performance (Pf): Mean the character is high accuracy speed and robustness of technology used.
- Circumvention (C): Mean the characteristic must be easy to prevent the system using fraudulent methods.

LITERATURE REVIEW

A brief review of works published about Hybrid Technique using for iris recognitions listed below:

- Sahmoud (2011) proposed method is used "1D log-Gabor wavelets" for encoded iris image and "Hamming distance" used for matching. For iris image, this method used CHT for segmentation after segmentation all iris segmented will normalized. 310 images selected and taken from CASIA v3.0- interval; the images belong to 22 persons (160 left's iris images and 150 right's iris images). Best images from the "CASIA-Iris-Interval".
- Das (2011) published a paper in which described iris recognition approach using ‘CED’ and used ‘CHT’ for localization of iris. This method gained 80% success rate when he was applied on "CASIA, - v3.0-, interval" database, Gabor wavelets used to extract feature to obtain better feature vector. The matching process done by using Hamming distance; this approach gains an FRR of 5.26 and FAR of 4.72.
- Lokhande and Bapat (2013) they proposed method used for iris recognition, this method depends on "Haar, wavelet" packet. The information of the iris is encoded using wavelet packets energy. A

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comparison published between the gained results of proposed method and Gabor wavelet results. The result shows the computational complexity is less than Gabor wavelet method. They conclude that when using "CASIA,-v3.0- and interval gain on accuracy 97%.

- Darabkh *et al*. (2014a, 2014b) proposed iris recognition system used for extracting the features vector 'pixels mathematical operations and sliding window'. This method operated to reduces the required time to acquire an image and the effect of changing the intensity of light is removing. The proposed method checked on 693 images for "CASIA,-v1.0 databases" and the accuracy attained was 98.54%.
- Mohammed (2014) proposed two approaches for iris recognition system. The first system is First Order Statistic methods (FOS) and the second system depends on Second Order Statistic methods (SOS), utilize GLCM. For each system the mean, standard deviation, coefficient of variation and entropy computed. The features computed directly on image histogram. The accuracy of these methods is estimated by using 360 eye images to 30 person for "CASIA,-v4.0-interval database and using 400 eye images to 100 person for "CASIA,-v1.0 database. The result shows a successful rate 99.4% when using FOS and 86.67% using SOS for CASIA,-v4.0 and 98.5% using FOS for CASIA,-v1.0.
- Abdullah and Abdullah (2015) suggested iris recognition wavelet transform for two types of filter, Haar and Daubechies (db4) to get more accuracy. When the feature extracts the matching operation performed by artificial feed forward neural network with back propagation algorithm. This matching method used for training and testing iris image. This method used 10 persons and each person 7 images from CASIA v1.0 database; accuracy rate has 84.2% for Haar filter and 92.8% for Daubechies filter. The training image is 5 and testing image is 2.

LAYOUT AND PURPOSE

The present work divided to the following: Proposed method, Experimental work, Result and discussion, Conclusions and Reference. The purpose of this study is to use a new method for iris recognition. This method includes used Gabor wavelet and Zernike moment to extract the features of iris.

PROPOSED METHOD

Gabor wavelet: Daugman (1993), a Professor of Cambridge University (Patil *et al*., 2012) suggested of iris recognition by using an exemplary and effective order, from through the implementation of a two-dimensional version of Gabor filters on the picture data. To extract information of image data by using a decomposition derived. A quad-rapture couple of Gabor filters using to the analysis of a signal. With determining a real portion by a cosine and an imaginary portion by a sine modulated by a Gaussian (Lee, 1996). The even and odd symmetric components respectively are real and imaginary definition to these filters. The frequency of the sine/cosine wave determines the frequency center of the filter and the width of the Gaussian determines the bandwidth of the filter. The optimal resolution can obtain in time and Frequency domain by Gabor wavelet. To extract features by Gabor wavelet, Gabor filter is performed with five scaling and eight orientation. Gabor filters used to texture analysis to obtain feature extraction for both local and global details in an iris, the feature value is the Local Energy and Mean Amplitude of each filtered image constitutes the components of our feature vector. These features arranged to form feature vector (Iris Codes). Gabor wavelet defined as follow:

$$Gabor(x,y) = e^{-\pi[\frac{(x-x1)^2}{\alpha^2}+\frac{(y-y1)^2}{\beta^2}]} * e^{-2\pi i[u(x-x1)+v(y-y1)]} \quad (1)$$

where, $x1$, $y1$ position in the photo, u, v specify modulation which has spatial frequency $\omega=\sqrt{u^2+v^2}$ and α, β specify effective width and length.

Zernike moment: Zernike moments can be defined are a complicated number by which a picture is drowned on to a group of 2D complicated Zernike polynomials. In general, Zernike moment computes a numeric magnitude at some distance from a referential points or axes. The definition of Zernike polynomials are a set of perpendicular polynomials, which known on the unit cylinder, moments are the projection of the photo function onto these perpendicular basis functions. The turning invariant feature of explaining a character image styles used to determine the magnitude of moments (Kim and Kim, 2008). The information of photo is independent and unique by participation each moment through the perpendicular property of Zernike polynomials. Represent data with no redundancy and handle overlapping of information between the moments can consider it features of Zernike polynomials (Arora *et al*., 2008). The pattern recognition and content-based image recovery (Arora *et al*., 2010) represent from the applications that used Zernike moments as feature sets because the features that have Zernike moments (Arora *et al*., 2009). The features of compound handwritten can extract by using Zernike moment due the specific aspects and properties for these moments. Geometric moments that cause redundancy for the information can be Disposal by using Zernike moments this method introduced by Teague (Duda *et al*., 2000). In 1934 was the first suggestion for Zernike moment by Zernike (Chong *et al*., 2003). Order p and repetition q of a picture for Zernike moments of with intensity f(r, θ) defined as follows (Hwang and Kim, 2006):

$$Z(M_{pq}) = \lambda_Z(p, N) \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} R_{pq}(k_{it})\, e^{-jp\theta_{it}} f(i, j) \quad (2)$$

where,

$$k_{it} = \sqrt{r_i^2 + c_j^2}\ ;\ \lambda_p(p, N) = \frac{p+1}{N-1}$$

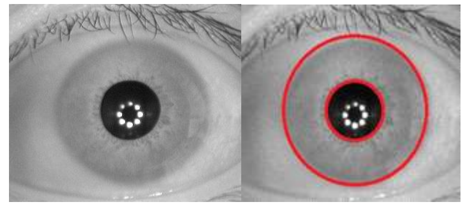
$$r_i = \frac{2i}{N-1} - 1\ ; \quad \theta_{it} = \tan^{-1}\left\{\frac{c_j}{r_i}\right\} \quad c_j = \frac{2j}{N-1} - 1$$

$$R_{pq}(k_{it}) = \sum_{k=0}^{\frac{p-|q|}{2}} \frac{(p-k)!}{k!\left(\frac{p+|q|}{2} - k\right)!\,\left(\frac{p+|q|}{2} + 1 - k\right)} r^{p-2k}$$

EXPERIMENTAL WORK

Image preprocessing: An image iris must be preprocessing because it couldn't use directly without enhancement process, The focus in image preprocessing on extract the region important such as iris region include the part between pupil and sclera and Neglecting of the unimportant area such as the pupil, eyelash and eyelid where it is considered an unimportant area. The accuracy of iris location in image preprocessing will influence by the later steps such as matching and feature extraction. Before feature extraction, the accuracy of iris location is important and the inner and outer boundary are determined. In addition, the change in distance between cameras to the face may possible result a change in the size of this iris (Arvacheh, 2006; Daugman, 2004). The preprocessing performed by the following steps:

Localization of iris: Localization of an Iris represented the important step in recognition systems, because of the accuracy of this steps was governing of all the subsequent steps. The quality of eye image will success the localization (Jain *et al*., 2004). The localization of iris determines the area between the outer boundary of the sclera and the inner boundary of the pupil from an eye image. Both of inner and outer boundary of iris can represent as circles (Arvacheh, 2006; Daugman, 2004). Therefore, the find of the centers for pupil and iris are important steps in the iris localization. Canny edge detection and Hough transforms are the methods, which used to find all of Iris center in the present work, pupil center, iris radius and pupil radius. Depending on this localization step, iris region will separated from eye. The preprocessing steps described in the Fig. 1; part (a) is the original photo, part (b) is iris localization preprocess.



(a) Original image (b) Iris localization

Fig. 1: Preprocessing steps, original iris image and Localization process

Normalization of Iris: Normalization process refers to transform the localized iris region from polar coordinates to Cartesian coordinates. The iris radius (r) and angle (θ) used during the normalization stage to determine the rectangular size of the iris image and can significantly appear the iris recognition rate. This normalization referred to as using Daugman's rubber sheet model (Karbhari *et al*., 2014). In the present study the two rectangular image parts of are used with equal size, marked using Iris BEE implementation, Depending on the value of the center of iris gained from iris localization it will take two parts left and right from the iris. These two parts will separated into two segments (a) and (b) as shown in the Fig. 2. The equation of normalization is the following below:

$$I\big(x(r,\theta), y(r,\theta)\big) \rightarrow I(r,\theta)$$

$$x_n = x_{center} + r\sin(\theta)$$

$$y_n = y_{center} - r\cos(\theta) \quad (3)$$

$$r = \sqrt{(x_n)^2 + (y_n)^2}$$

$$Normalized_{image}(i,j) = I(x_n, y_n)$$

where, (x_{center}, y_{center}) is the center coordinate of the iris image, I (x_n, y_n) is the value for iris region and θ is the angle (0°, 360°).

A proper normalization is necessary to satisfy main three variations. These three advantages of normalization were in the following (Jain *et al*., 2004):

- The variation in pupil size because of modifications in outer lighting might effect on iris volume.
- It guarantees that the irises of various person mapped to a common photo area not with standing the variant in scholar bulk across topics.
- Through the matching, the degree can identify on iris in a simple translation process. Depending on plan eye and head, rotation can implement this process.

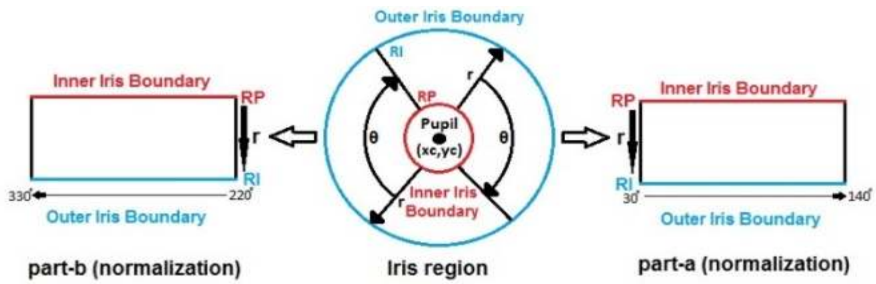


Fig. 2: Normalization steps

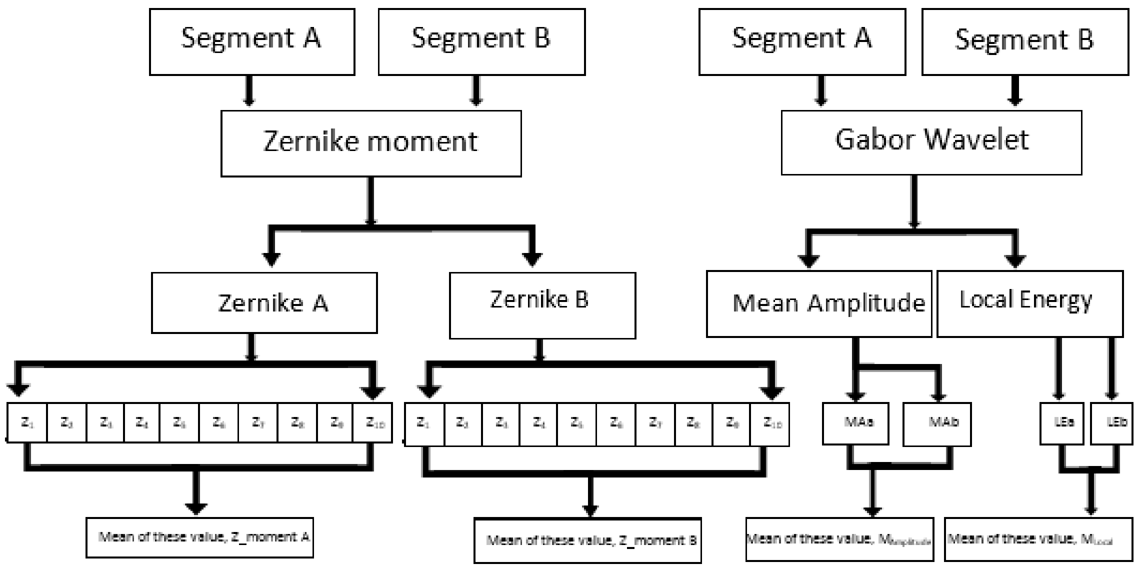


Fig. 3: Feature extraction using Gabor and Zernike

Fig. 4: The result collects (Iris Code)

Feature extraction: To extract features, different algorithms used in order to obtain accurate and efficient authentication. The implement action of the iris recognition system used by MATLAB image processing. An iris image database named CASIA-V4-interval is used. The image used in the present work for left eyes of ten people. Each person has seven screenshots of eyes (4 images to training and 3 images for testing). Gabor wavelet applied on each part of normalized iris segments. The Gabor filter with five scales and eight orientations. For each part, fourteen matrices will gained named response matrix. From this matrix, two value will be extracted named Local Energy and Mean Amplitude as iris features. These features calculated by Eq. (4) and (5) in the following:

- Local Energy is the summation of squared matrix values gained from response matrix as present in the following equation:

$$\text{Local Energy} = \sum_1^n \big(x(i,j)\big)^2 \quad (4)$$

- Mean Amplitude is e summation sum of absolute values of each matrix value from a response matrix:

$$\text{Mean Amplitude} = \sum_1^n |x(i,j)| \quad (5)$$

where,
(x) = The value of each pixel in response matrix
(i) = The number of row of each response matrix
(j) = The number of column in the response matrix
(n) = The number of response matrix.

The value of local energy and mean amplitude are the mean value gained from part (a) and (b).

The second method for feature extraction is Zernike moment; the parts of iris normalization will pass through Zernike function and will get ten value for each part. After that, the average value will take for these ten values and save the results in the feature vector. Figure 3 show the feature extraction by Gabor and Zernike in details.

Finally, row vector (Iris Code) will create. The four features extracted from the Fig. 3 in addition to pupil radius (Rp) and iris radius (Ri) will store in the row vector. The row vector explained in the Fig. 4.

The matching process published by count number of similarities and Euclidean Distance measure between values of the feature vector of the tested image and saved vectors for training images.

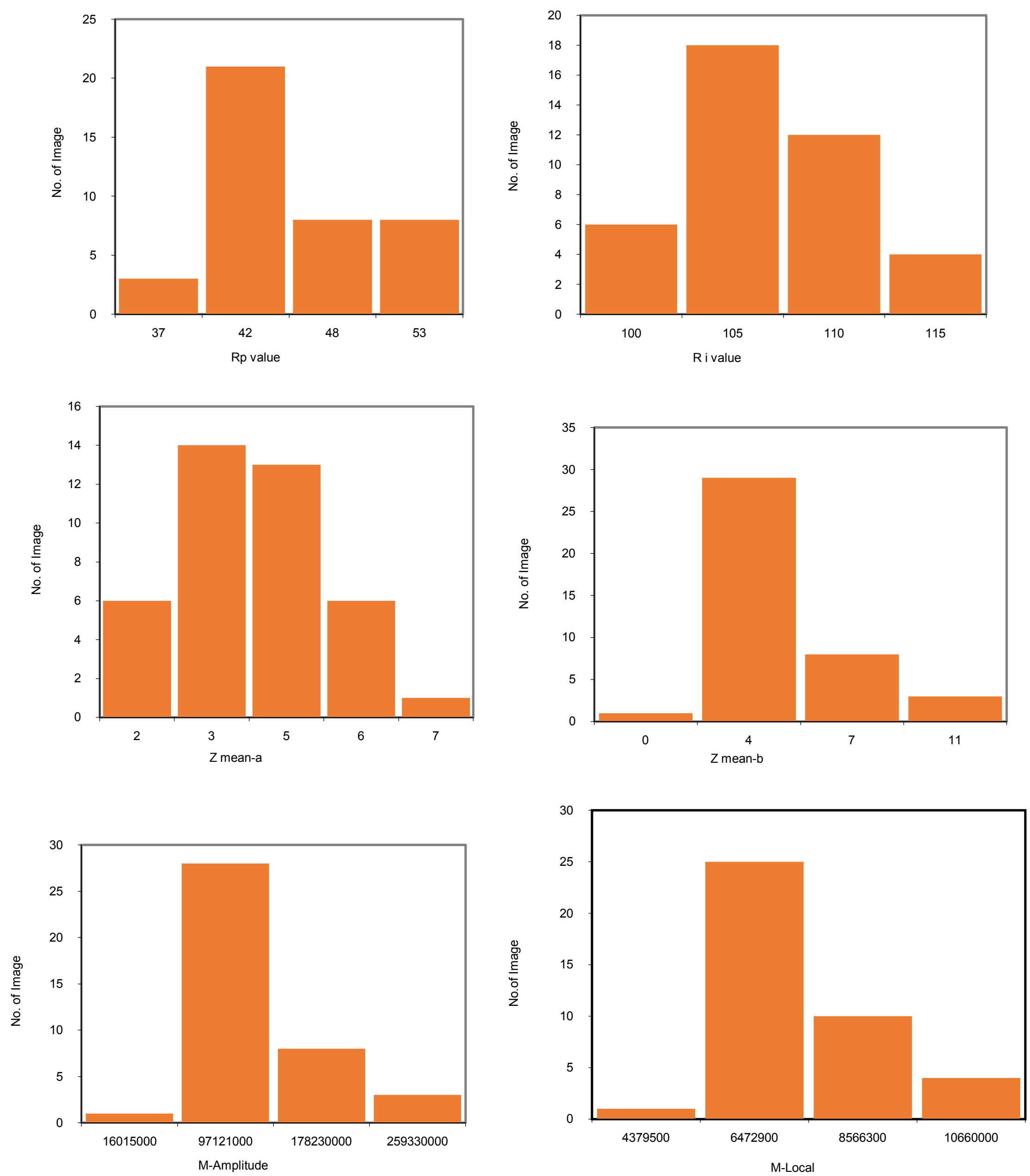


Fig. 5: Histogram distribution of the database

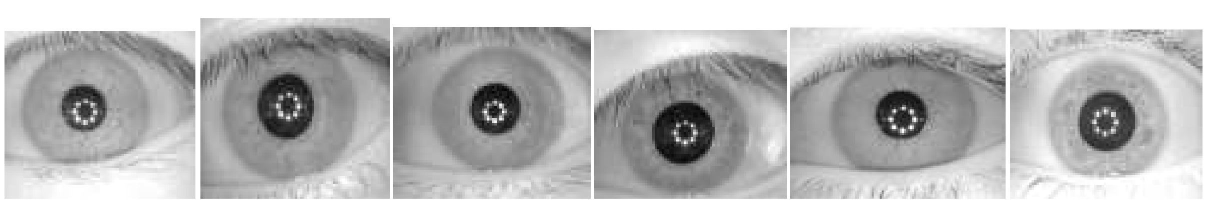


Fig. 6: Some CASIA v 4.0 interval images

Table 1: Matching process for 1st person

Feature	R_p	R_i	Z_A	Z_B	$M_{Amplitude}$	M_{Local}	Matching
Image 1	38	103	2	6	14141498	4706489	Match
Image 2	35	105	2	10	24212577	5474370	Match
Image 3	35	105	2	12	24484388	5505667	Match

Table 2: Matching process for 2nd person

Feature	R_p	R_i	Z_A	Z_B	$M_{Amplitude}$	M_{Local}	Matching
Image 1	42	103	4	8	260241915	10692499	Match
Image 2	42	103	3	4	259028864	10310659	Match
Image 3	45	103	5	4	32772564	7397956	Match

Table 3: Matching process for 3rd person

Feature	R_p	R_i	Z_A	Z_B	$M_{Amplitude}$	M_{Local}	Matching
Image 1	45	115	3	5	23520968	5265805	Match
Image 2	50	115	3	4	15553782	4914986	Match
Image 3	48	113	4	3	16052473	5244377	Match

Table 4: Matching process for 4th person

Feature	R_p	R_i	Z_A	Z_B	$M_{Amplitude}$	M_{Local}	Matching
Image 1	38	103	5	2	19059127	5414318	Match
Image 2	40	103	4	3	126466659	7659982	Not match
Image 3	35	103	4	2	23011069	5182898	Match

Table 5: Matching time for four person

Features	Matching time seconds
Image 1	0.006150
Image 2	0.006185
Image 3	0.007481
Image 4	0.008723
Image 5	0.006375
Image 6	0.007466
Image 7	0.006883
Image 8	0.006602
Image 9	0.007297
Image 10	0.007837
Image 12	0.006045

Table 6: Un-matching time for four person

Features	Un-matching Time Seconds
Image 11	0.00600

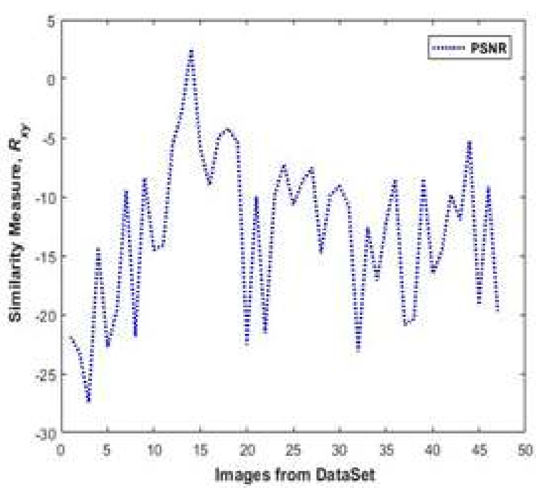


Fig. 7: Matching image1, 1st person

RESULT AND DISCUSSION

In order to assess the adequacy of the database, descriptive statistics of each data set presents in the database were determined. While the histogram distribution of the database is shown in Fig. 5. This database can use for the comparison of the performance of existing feature extracted with the exact value. The database used in the persent work is CASIA v-4.0

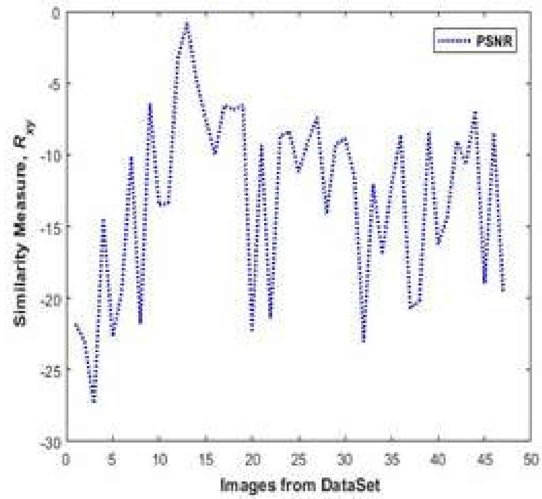


Fig. 8: Matching image2, 1st person

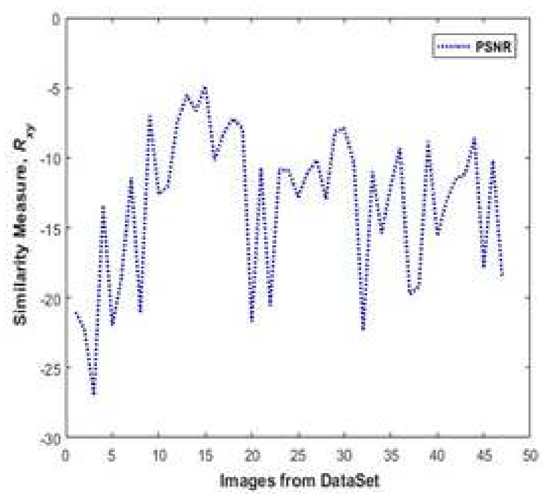


Fig. 9: Matching image3, 1st person

interval; some of this database presented in Fig. 6. The result show when applied the method to ten persons, matching case ratio about 70% and in generally the time of matching case less than un-matching. The numeric values explain the efficacy of matched image is very vast when compared with un-matching. Table 1 to 4 show the numeric value for four persons, which explain matching and un-matching cases. Table 5 show the time of matching and Table 6 show the time of un-matching cases.

PSNR (Peak Signal-to- Noise Ratio) value represent the criterion of performance for feature extraction. The two-person date used to determine the efficiency criteria. Figure 7 to 9 represent the matching case for first person using extracted feature to determine PSNR. Figure 10 to 12 represent the matching and un-matching case for the second person-using feature extracted to determine PSNR. Figure 13 to 15 represent the matching case for the first person using a testing image with training image before feature

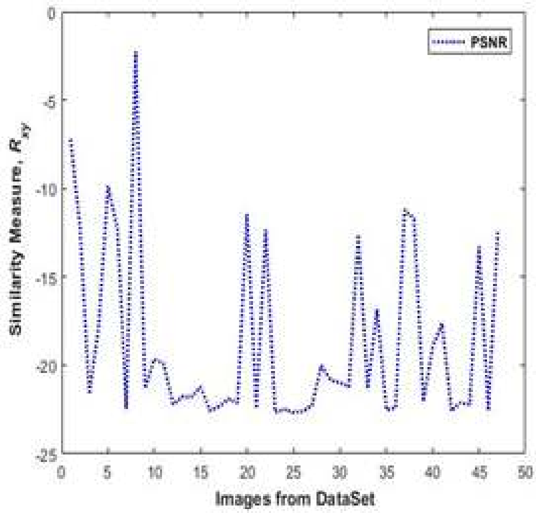


Fig. 10: Matching image 1, 2[nd] person

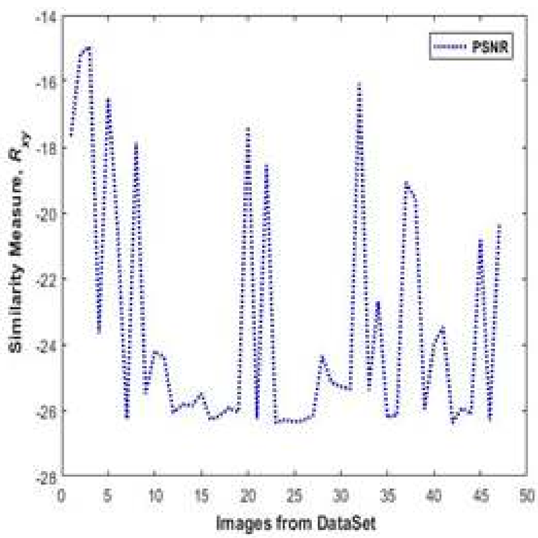


Fig. 11: Matching image2, 2[nd] person

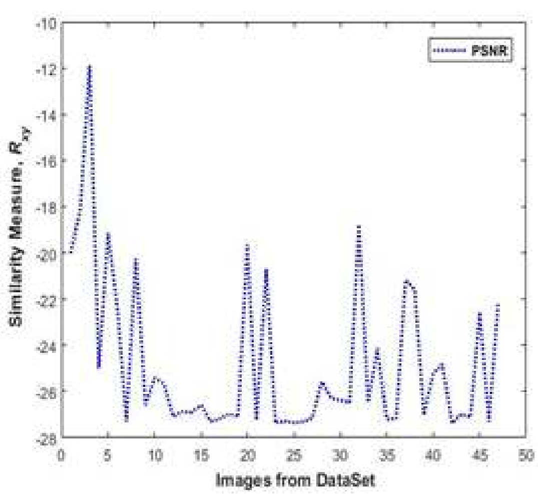


Fig. 12: Un-matching image3, 2[nd] person

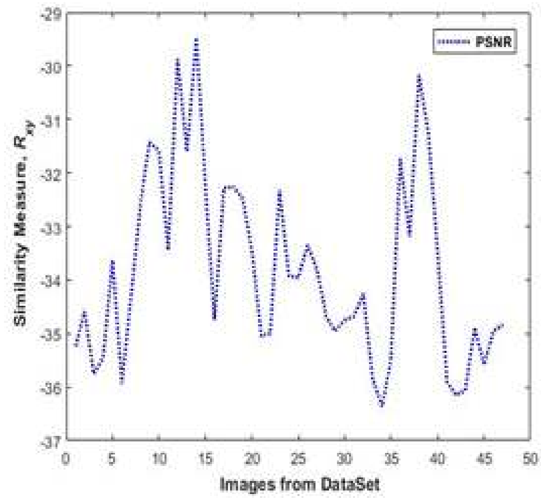


Fig. 13: Matching image1, 1[st] person

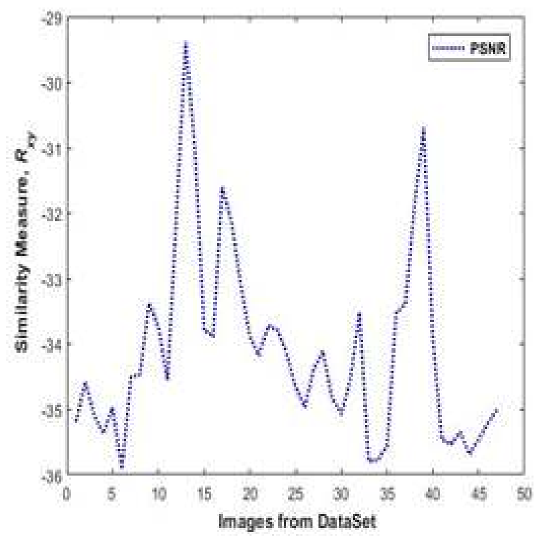


Fig. 14: Matching image2, 1[st] person

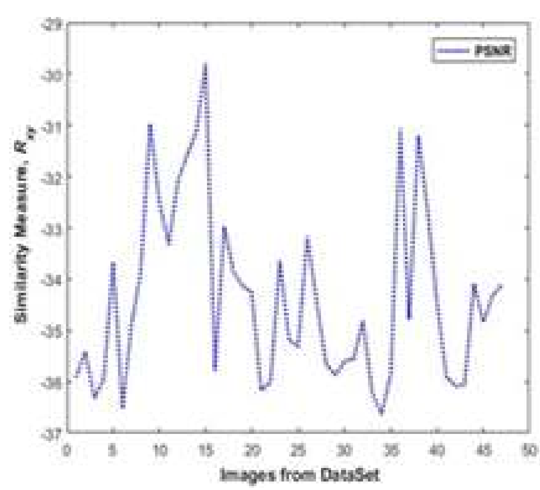


Fig. 15: Matching image3, 1[st] person

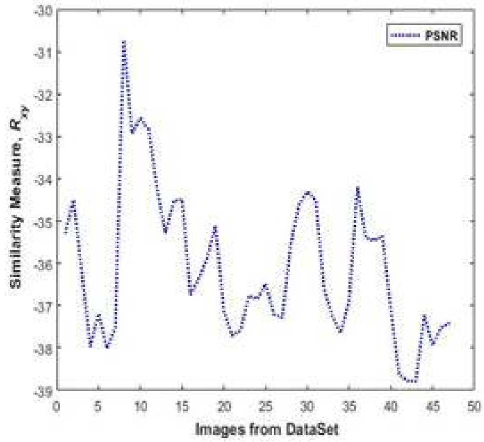


Fig. 16: Matching image1, 2nd person

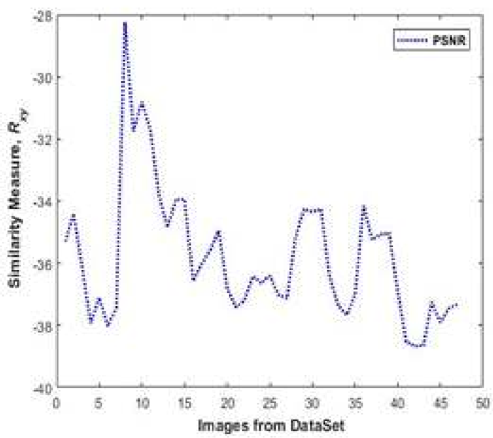


Fig. 17: Matching image2, 2nd person

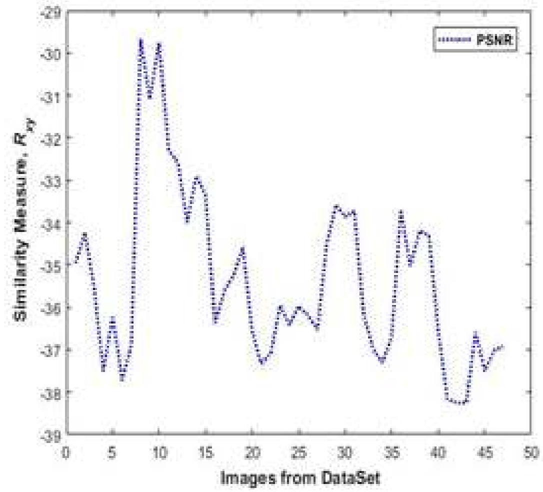


Fig. 18: Un-matching image3, 2nd person

extracted to determine PSNR. Figure 16 to 18 represent the matching and un-matching case for the second person using a testing image with training image before feature extracted to determine PSNR.

In addition, Fig. 19 to 22 show the efficiency of feature testing compared with the feature testing for four persons and explain matching and un-matching cases.

CONCLUSION

- The iris recognition has some advantages that make it appropriate for process recognition more than other feature recognition, such as uniqueness, stability, high recognition rate, etc.

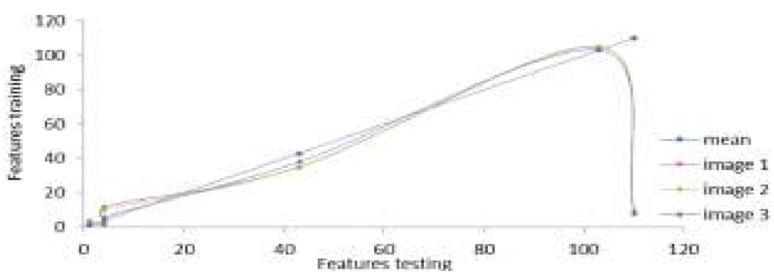


Fig. 19: Efficiency of IRS for 1st person

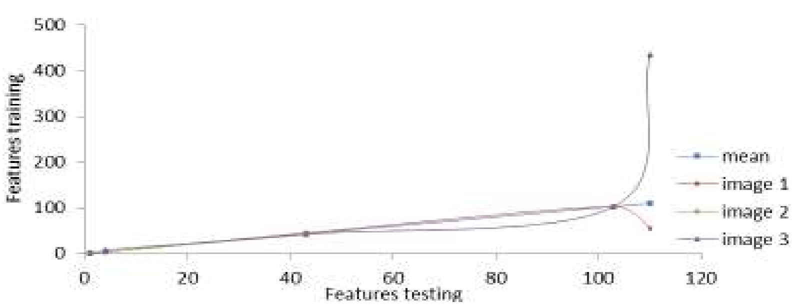


Fig. 20: Efficiency of IRS for 2nd person

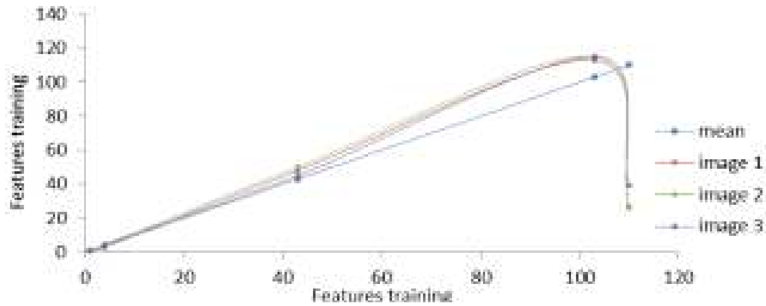


Fig. 21: Efficiency of IRS for 3rd person

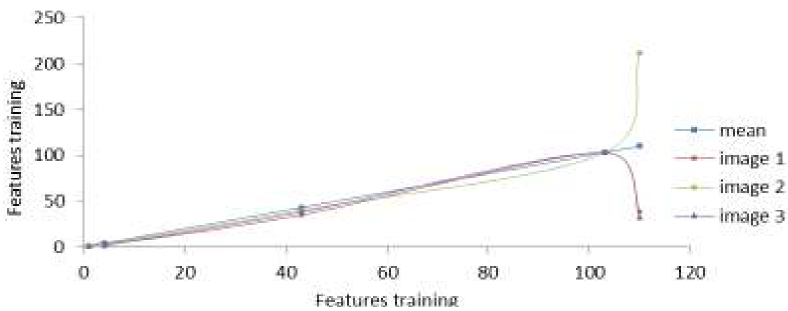


Fig. 22: Efficiency of IRS for 4th person

- Many of work suggested by researchers present that are no single technique can involve all operational environments which admissible and given optimal biometric characteristic.
- The operation of avoids eyelash and eyelid reduce the time for recognition.
- In addition to the image is not matching, the numerical value is a closet to its training image.
- The time required is very low with high verification rate of proposed system.
- The result of combination between Gabor and Zernike give high verification result.

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