ISSN: 2321-7782 (Online)
Volume 2, Issue 10, October 2014
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Survey Paper / Case Study
Available online at: www.ijarcsms.com

IRIS Recognition System Based On DCT - Matrix Coefficient

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Abstract: ***This paper presents a new iris coding method based on discrete cosine transform (DCT) Matrix coefficients. The feature extraction capabilities of the DCT Matrix are evaluated on largest publicly available eye image UBIRIS database. We have taken 990 images of 198 different eyes from the UBIRIS database. After successful implementation of the algorithm on the database, we have achieved 99.99% percent Recognition Rate (RR) with 0.01% false accepts and only 0% of false rejects. Individual feature bit of the iris are optimized for matching through XOR approach of Hamming distance calculation.***

Keywords: ***Segmentation, Normalization and Enhancement, Feature Extraction DCT, Matching and Results.***

I. INTRODUCTION

Iris recognition has been one of the most important and challenge research subject in biometric field [6][7][8][15]. In present world, the security is more important than ever before. Biometric Systems are automated methods of verifying or recognizing the identity of a living person on the basis of some physiological features (face, finger print, palm print, retina, iris) as well as behavioural features (signature, key stroke, voice). Some of the most used biometric characteristics are shown in the fig-1. A biometric system based on **physiological** characteristics is more reliable than one which adopts **behavioral** features.

Some common biometric methods are : Face recognition, Finger print, voice recognition, Hand geometry, iris recognition etc. but iris recognition is most reliable method as compared to all other methods due to its advantages such as reliability, stability etc. Biometric methods involves two important processes: verification and identification. Verification involves one-to-one match i.e matching captured biometric with specific ID stored in database where as identification involves one-to-many match i.e matching captured biometric among many known ID's.

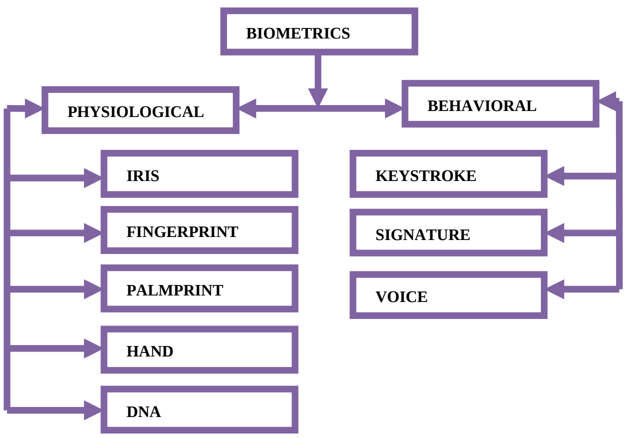

Figure 1: Types of Biometrics

Among all biometric technologies, iris recognition is one of the best technologies for person identification and security because of the following advantages:

1. The pattern of Human iris is remaining stable, and relatively constant for throughout the lifetime since the age of one year. [2, 4].
2. The texture patterns of iris don't correlate with genetic determination because the formation of iris depends on the initial environment of embryo[3]. And even the pattern of left and right eye for a given person is different.
3. Iris can't be modified through surgery without risk.
4. The iris recognition is non-invasive and don't cause the damage to identifier.

II. Related Work

John Daugman, was first implemented a working automated iris recognition system [1]. The Daugman system is patented [4] and the rights are now owned by the company Iridian Technologies. The Daugman made a use of multiscale Gabor filter to demodulate texture Phase Structure information of iris filtering of iris image with a family of filter resulted in 1024 complex-valued phasors which denotes the phase structure of iris at different scales. Each phasor was then quantized to one of the four quadrants in the complexed plane. The resulting of 2048-components iris codes to describe an iris. The difference between the pair of iris code was measure by their hamming distance. Wildes et al. [5][9], represented the iris texture with a Laplacian pyramid constructed with four different resolution level and used normalized correlation to determine whether the input image and the model image are from the same class. Boles and Boashash [10], calculate a zero crossing representation of one dimensional (1D) wavelet transform at various resolution levels of concentric circle on an iris image to characterize the texture of the iris. the iris matching is based on two dissimilarity function Lim et al.[11], decomposed an iris image into four levels using 2-D Haar wavelet transform and quantized the fourth level high frequency information to form a code of 87 bit. A improved version of competitive learning neural network was implied for classification. The algorithms by Lim et al. are used in the iris recognition system developed by the Ever media and Senex companies.

III. Overview of Our Approach

We broadly classify our work in three parts. The first part is known as the eye image Pre-Processing in which we have done Segmentation, Normalization, extraction of "Region of Interest", and Image Enhancement. All these steps are described in this paper. In second part we have done iris feature extraction using DCT Matrix and in third part we have perform Matching. Lastly we have discussed our result and give conclusion of our approach.

IV. Image Pre-Processing

Segmentation

The proper segmentation is the very important part the iris recognition system. For getting the segmented eye we first generated the edge map of the eye using the canny edge detector and on the generated edge map we perform the circular Hough transform as suggested by Wildes et al. [12][13] , which is used to detect the iris/sclera boundaries first and iris/pupil boundaries later. We manually set the radius range for iris and pupil boundaries by detecting their pixel value variation. The radius range for pupil boundaries were found 30 to 80 pixel and iris boundaries found 90 to150 pixel.

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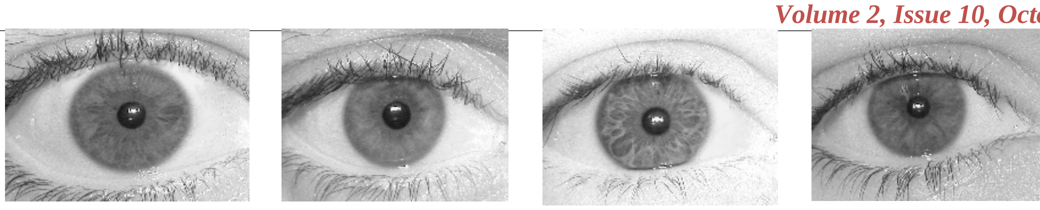

Figure 2: Input Eye Images

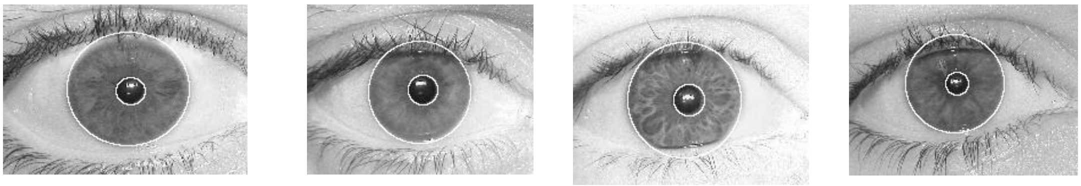

Figure 3: Segmented Eye Images

Normalization and Enhancement

The iris of different people are of different sizes , and even the captured images of irises from the same eye, the size may changes due to variation of light and changes of the camera-to eye distance etc. That's why for the purpose of achieving more accurate recognition, it is necessary to compensate for such deformation. Through normalization we produces the constant dimension iris region, so that the photographs of the same iris under different conditions will retain the similar characteristic features at the same spatial location. The normalization not only reduces to certain extent the distortion of the iris caused by pupil movement but also simplifies subsequent processing. For normalization we have used similar approach as used by Daugman [1]. Additionally for further reducing the processing time and enhance the feature extraction process as well as matching performance. we define the region of interest of the iris for where we perform the feature extraction process, because the part of the iris near to the pupil contain most of the information and region near to the sclera contain few texture characteristics and are easy to occluded by eyelids and eyelashes therefore for performing feature extraction process we only take 67% of iris image a region close to the pupil and we discarded rest of the part of iris by defining region of interest through Matlab image processing tool. the obtained normalised iris has low contrast and may have non uniform brightness, all these things may affect the feature extraction and matching. In order to achieve well distributed texture image we adjusting image intensity values first, after that we employ histogram equalisation and finally contrast and sharpness improving.

Figure 4: Normalized Iris Images

Figure 5: Extracted Region of Interest from Normalized Iris

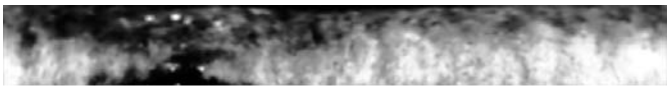

Figure 6: Final Enhance Images

Feature Extraction

For feature extraction of the normalized iris image, ***Discrete Cosine Transform*** **(DCT)** matrix [20] is used. The DCT matrix is given by –

 ISSN: 2321-7782 (Online)

$$\mathbf{T_{ij}} = \left\{ \begin{array}{c} \frac{\mathbf{1}}{\sqrt{\mathbf{n}}} \ \mathbf{if\ i = 1} \\ \sqrt{\frac{\mathbf{2}}{\mathbf{n}}}\, \mathbf{cos}\left[\frac{(\mathbf{2j+1})\mathbf{i\pi}}{\mathbf{2n}}\right] \mathbf{if\ i} > 0 \end{array} \right\}$$

For a 4x4 block, the following results are observed and these are shown in the matrix below:

$$T = \begin{bmatrix} 0.5000 & 0.5000 & 0.5000 & 0.5000 \\ 0.6533 & 0.2706 & -0.2706 & -0.6533 \\ 0.5000 & -0.5000 & -0.5000 & 0.5000 \\ 0.2706 & -0.6533 & 0.6533 & -0.2706 \end{bmatrix}$$

Where the first row i=1 has all entries equal to 1 as expessed from equation, the column of T form an orthonormal set so T is an orthonormal matrix. The DCT matrix is more efficient and faster than two dimensional DCT for square input images, it is used in many image compressing technique. In our Case we divide the input image into the set of 4-by-4 blocks and afterwards the two dimensional DCT is computed for each blocks to obtained the DCT coefficients. The obtained DCT coefficients are than binarized to form the templates of the image. Now to reduce the size of template only the most discriminating coefficients of DCT matrix are extracted and binarized. And the Remaining ones are discarded. The wide range of experiment were undertaken to determine the most effective combination of bits to form the reduce template matrix. To achieve this resulted combination. Initially the entire set of the test data is coded for every possible combination and the combination producing the best separation between the matching and non matching Hamming Distance was chosen as a final matrix.

Matching

For comparing the two iris codes, the hamming distance algorithm is employed. Since the iris region contains features with very high degrees of freedom, and each iris produces a bit-pattern which is independent to that produced by another iris, whereas the codes produced by the same iris would be similar. If two bits patterns are completely independent, then the ideal Hamming distance between the two patterns will be equal to 0.5. It happens because independent bit pattern are completely random. Therefore, half of the bits will agree and half will disagree between the two patterns. The Hamming distance is the matching metric employed by Daugman, and calculation of the Hamming distance is taken only in bits that are generated from the actual iris region. The Hamming distance will be defined as follows:

$$HD = \frac{1}{N}\sum_{j=1}^{N} X_j \oplus Y_j$$

Where X_j and Y_j are the two bit wise template to compare and N is the number of bits represented by each templates. The Hamming distance can be computed using the elementary logical operator XOR (Exclusive-OR) and thus can be completed very quickly. In the present case, the HD is 0.445 which signifies that if the hamming distance between the two templates is below 0.445 than both the irises are of same eye and if the HD value falls above 0.445, it signifies that both the irises are from different eye.

V. RESULTS

To evaluate the performance of the proposed method, the iris images are collected from the largest available UBIRIS database version4.1. Almost 990 images of 198 different persons are taken. The entire testing is done on the ***Matlab*** 7.7 platform and the laptop of 1.86GHz processor and 2GB RAM is used to run our prototype model. The following results are obtained which are shown in figure7, 8 and 9.

As it is clear from figure 9, that the inner class and inter class hamming distances are lying separately and there is no overlapping between both the hamming distances. The table 1 shows the total outcome of our algorithm.

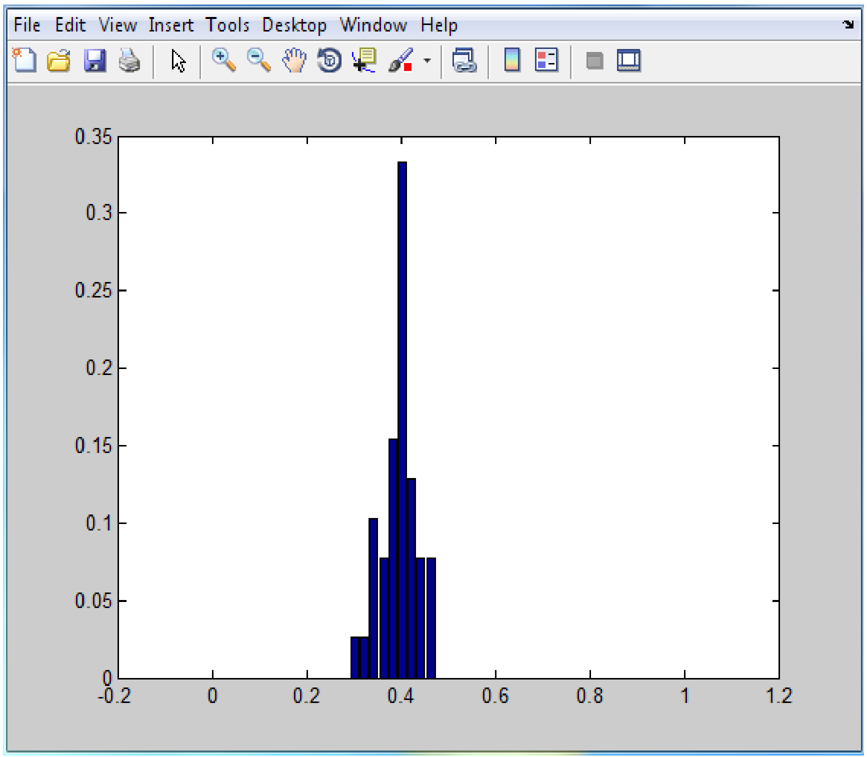

Figure 7: Distribution of inner class hamming distance for UBIRIS database.

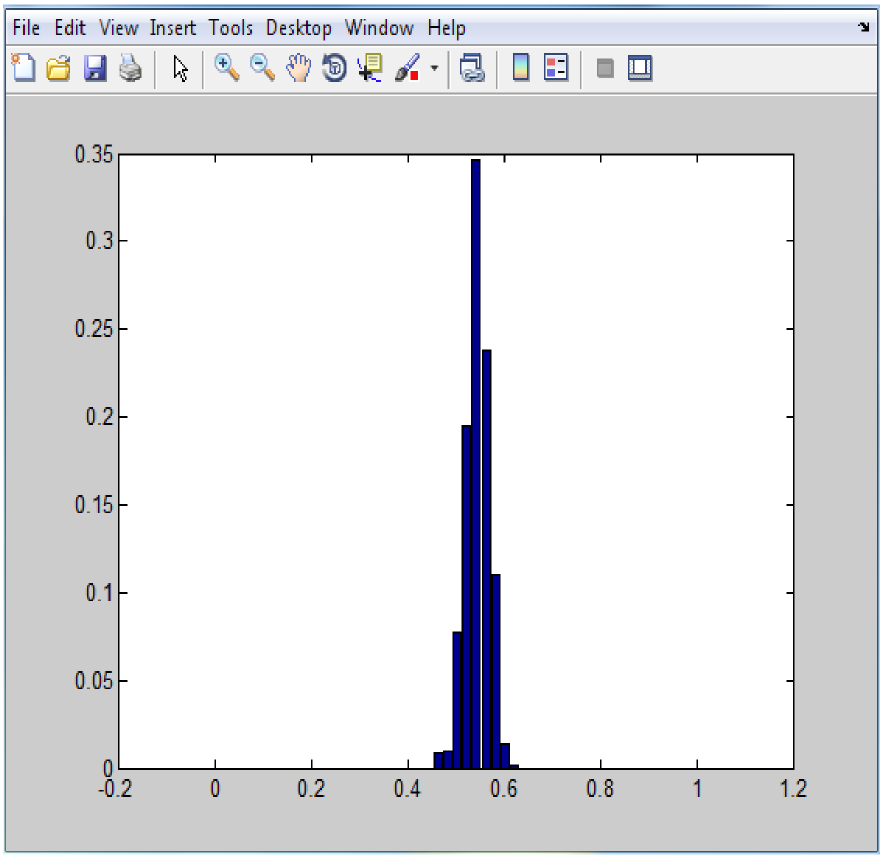

Figure 8: Distribution of inter class hamming distance for UBRIS database

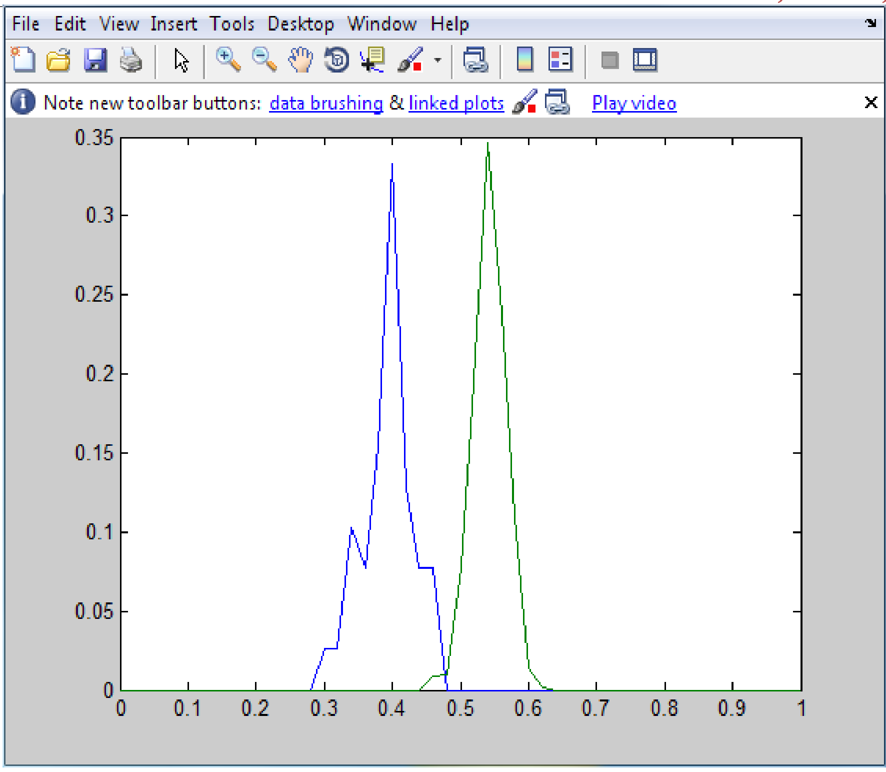

Figure 9: Distribution of inner class and inter class hamming distance for UBRIS database.

TABLE 1:
FAR AND FRR

	HD	FAR	FRR
Proposed Method	0.445	0.01%	0%

Where the **False Acceptance Rate** (FAR) and **the False Rejection Rate**(FRR), defined as the accepting of a false person and rejecting of a genuine person for a given value of hamming distance respectively.

The performance evolution of any iris recognition system is done on the basis of **Recognition Rate** (RR) and **Equal Error Rate**(EER), defined as the number of the correct recognition and the point where the FAR and FRR both are equal in value respectively. In this case, the value of RR is 99.99% and EER is 1.0%. The table 2 shows the comparison of existing and well-known iris recognition and table 3 shows the speed comparison between existing systems. Both the tables show that the algorithm which has been proposed here has a higher recognition rate as well as higher speed. Although, Daugman system has high recognition rate than the proposed system, but the Daugman system comparatively has low speed. On the other hand the Boles system offers high speed but it has low recognition rate and higher EER. Therefore when both speed and recognition rate are taking into consideration, the proposed algorithm is far better than the existing ones.

Table 2:
Comparison between RRs and EERs

Methods	Recognition rates	Equal error rates
Daugman(5)	100%	0.08%
Boles(8)	92.64%	8.13%
Tan(12)	99.19%	0.57%
L.Ma(19)	99.60%	0.29%
Proposed	99.99%	1.00%

Table 3:

Speed comparison between existing methods

Methods	Feature Extraction(ms)	Matching (ms)	Total(ms)
Daugman(5)	682.5	4.3	686.8
Boles(8)	170.3	11.0	181.3
Wildes(6)	210.0	401.0	611.0
Tan(12)	426.8	13.1	439.9
L.Ma(19)	260.2	8.7	268.9
Proposed	148.05	11.41	159.46

VI. Conclusion

This paper presents an iris recognition method based on Discrete cosine transform (DCT) Matrix. As the result Shown 99.99% recognition rate can be achieved using the proposed algorithm and also the recognition time taken by this method is very low so we can draw the conclusion that this is the one of the best technique which can be used for iris recognition.

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