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Investigation and Analysis of Hough-DCT-Hamming Distance Based Method of Iris Recognition

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***Abstract:** As we know that iris recognition is widely used biometric identification system. This system is having growing future in the area of security. In the real time security systems we need to have reliable, efficient, faster iris recognition system. Iris recognition process is consisting of iris segmentation, normalization, localization as well as matching techniques. And hence the performance of this system is majorly depends on use of such techniques. In this paper we will first present the literature review over the different methods for iris segmentation, iris encoding as well matching. Thereafter, we will present the experimental evaluation of Hough-DCT-Hamming distance based Iris Recognition system. We simulated this approach using MATLAB and different datasets.*

***Keywords:** Iris Segmentation, Hough Transform, Canny Edge, DCT, False Acceptance Rate, False Rejection Rate*.

I. INTRODUCTION

A biometric system provides automatic recognition some sort of unique feature or characteristic possessed by the individual. Biometric systems have been developed on fingerprints, facial features, voice, hand geometry, handwriting, the retina [1], and the iris. Biometric systems work by first capturing a sample of the feature, such as a digital sound signal for voice recognition, or taking a digital image for face recognition. The sample is then changed some sort of mathematical function into a biometric template. The biometric template will supply a normalized, efficient and highly discriminating representation of the characteristic, which can then be objectively compared with other templates in order to define identity. Most biometric systems give two modes of operation. An enrolment mode for adding templates to a database, and an identification mode, where a template is created for one-by-one and then a match is searched for in the database of pre-enrolled templates

A good biometric is describe by use of a feature that is; highly unique – so that the chance of any two persons having the identical characteristic will be least, stable – so that the feature does not change over time, and be easily catch, – in order to provide facility to the user, and prevent misrepresentation of the feature. 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 function of the iris is to control the amount of light entering from the pupil, and this is done by the sphincter and the dilator muscles, which coordinate the size of the pupil. The average diameter of the iris is 12 mm, and the pupil size can vary from 10% to 80% of the iris diameter [2].

The iris consists of a number of layers; the lowest is the epithelium layer, which contains compact pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two iris muscles. The thickness of stromal pigmentation defines the color of the iris. The externally visible exterior of the multi-layered iris comprises two zones, which often disagree in hue [3]. An outer ciliated, zone and an inward papillary zone, and these two zones are divided by the collarets – which appears as a zigzag pattern.

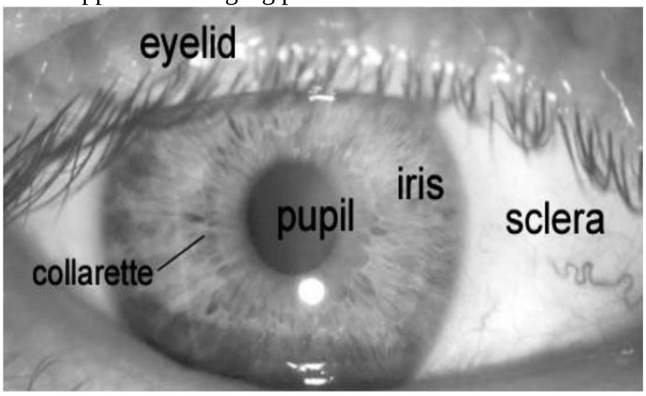

Figure 1: View of human eye

The iris is an externally visible, already protected organ whose unique epigenetic pattern remains stable throughout major life. These characteristics make it very attractive for use as a biometric for identifying individuals. Image processing techniques can be employed to substance the unique iris pattern from a digitized image of the eye, and encode it into a biometric template, which can be stored in a database. This biometric template check and purpose mathematical representation of the unique information stored in the iris, and allows compare to be made between templates. When a subject wishes to be identified by iris recognition system, their eye is first photographed, and then a template created for their iris scope. This template is then compared with the other templates stored in a database during either a matching template is found and the subject is identified, or no match is found and the subject remains unidentified. whereas prototype systems had been suggested previous, it was not until the early nineties that Cambridge investigator, John Daugman, implemented a employed automated iris recognition scheme [1][2]. The Daugman system is patented [5] and the privileges are now belongs to by the business Iridian Technologies.

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Even though the Daugman system is the most successful and most well known, numerous other systems have been developed. The most notable encompass the systems of Wildes et al. [7][4], Boles and Boashash [8], Lim et al. [9], and Noh et al. [10]. The algorithms by Lim et al. are utilized in the iris recognition system evolved by the Evermedia and Senex businesses. Furthermore, the Noh et al. algorithm is utilized in the 'IRIS2000' scheme, traded by IriTech. These are, apart from the Daugman system, the only other known financial implementations.

In this paper we have to investigate the presentation analysis of iris recognition methods such as Hough change, DCT, Hamming distance. Measure their performances in periods of false acceptance rate, false rejection rate.

II. LITERATURE REVIEW

2.1. Integrodifferential operator

This approach [5] is regarded as one of the most cited approach in the survey of iris recognition. Daugman uses an integrodifferential operator for section the iris. It finds both inner and the outer boundaries of the iris district. The outside as well as the inner boundaries are mentioned to as limbic and pupil boundaries. The parameters such as the center and radius of the circular boundaries are being searched in the three dimensional parametric space in order to maximize the evaluation functions involved in the model. This algorithm achieves high presentation in iris recognition. It is having a drawback that, it suffers from weighty computation.

2.2. Hough Transform

Here, an extant system has been used in order to provide a remedy to these challenges. Next topic is the iris localization. That is the image capture during the image acquisition will be a very larger image which contains iris as a part of it. Thus localization of the part that corresponds to the iris from acquired image is very much important. The confines detection has been presented through the gradient-based canny confines detector, which is followed by the circular Hough transform [2], which is used for iris localization. The final issue is the pattern matching. After the localization of the region of the acquired image which corresponds to the iris, the final procedure is to conclude if pattern agrees with the previously kept iris pattern. This stage involves alignment, representation, goodness of agree and also the conclusion. All these pattern matching advances relies mostly on the procedure which are nearly coupled to the noted image intensities. If there happens a greater variety in any one of the iris, one way to deal with this is the extraction as well as matching the groups of characteristics that are approximated to be more vigorous to both photometric as well as geometric distortions in the obtained images. The benefit of this procedure is that it provides segmentation correctness up to an span. The drawback of this approach is that, it does not supply any vigilance to eyelid localization (EL), reflections, eyelashes, and shaded which is more significant in the iris segmentation.

2.3. Masek Method

Masek introduced an open iris recognition scheme [3] for the verification of human iris essential character, and furthermore its presentation as the biometrics. The iris recognition system comprises of an automated segmentation system which localize the iris region from an eye image and furthermore isolate the eyelid, eyelash as well as the reflection districts. This Automatic segmentation was accomplished through the utilization of the circular Hough change in sequence to localize the iris as well as the pupil districts, and the linear Hough transform has been utilized for localizing the eyelid occlusion. Thresholding has been adjacent for isolating the eyelashes as well as the reflections. Now, the segmented iris district has got normalized in order to destroy the dimensional inconsistencies between the iris districts. This was accomplished by applying a version of Daugman's rubber sheet model, in which the iris is modeled as a flexible rubber sheet, which is unpacked into a rectangular impede with unchanging polar dimensions. finally, the iris features were encoded by convolving the normalized iris district with the 1D Log-Gabor filters and stage quantizing the output to produce a bit-wise biometric template. For metric matching, the Hamming distance has been chosen, which presents a measure of number of disagreed morsels between two templates. The drawback of [2] has been retrieved in this paper i.e., the localization of the circular iris as well as the student district, occlusion of eyelids as well as the eyelashes, and also the reflection happens. The drawback of this approach is that the iris segmentation is not that much accurate and furthermore the speed of the system is low.

2.4. Fuzzy clustering algorithm

A new iris segmentation approach, which has a robust performance in the attendance of heterogeneous as well as loud images, has been evolved in this. The method begins with the image-feature extraction where three discrete i.e., (x, y) which corresponds to the pixel place, and z which corresponds to its power standards has got extracted for each and every image pixel, which is followed by the submission of a clustering algorithm which is the fuzzy K-means algorithm[4]. This has been categorizing to classify each and every pixel and then develop the intermediate image. This correspondent image is then used by the edge-detector algorithm. As it has added homogeneous characteristics, this eases the tuning of the parameters which were required by the edge-detector algorithm. The main benefit of this procedure is that, it presents a better segmentation for non cooperative iris recognition. The main drawback in this procedure is that thorough (extensive) seek is required in order to recognize the around parameters of both the pupil as well as the iris boundaries.

2.5. Pulling and Pushing (PP) Method

A perfect (accurate) as well as a fast iris segmentation algorithm for iris biometrics has been evolved in this. There are mostly five major contributions in this. Firstly, a novel reflection removal method has been evolved in alignment to exclude the secularities involved in the input images, furthermore an Adaboost-cascade iris detector has been utilized in order to notice the iris in them and furthermore to omit the non iris image parts before farther processing such that redundant computations can be avoided. In supplement to this, a uneven iris center has been extracted in the iris images. Second contribution is that, starting from the uneven iris center, a novel puling and impelling (PP) [5] procedure has been developed in order to accurately localize the circular iris boundaries.

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The PP procedure exactly finds the shortest path to the accepted parameters. Third is that, a cubic smoothing spline has been adopted in order to deal with the noncircular iris boundaries. Fourth assistance is that, an effective method for the localization of the eyelids has been evolved. The main adversities of eyelid localization adversities such as pointed irregularity of eyelids as well as the disturbance due to the eyelashes has been addressed proficiently by a grade filter and also a histogram filter. Finally, the eyelashes as well as the shadows have been noticed with statistically learned proposition model. The benefit of PP method is the accuracy and speed. The drawback of this procedure is that the incident of the segmentation error.

III. PROPOSED METHODS OF IRIS RECOGNITION

Figure 2 showing the investigated framework of IRIS recognition system. We have used techniques like canny edge detection and Hough transform for iris segmentation, DCT for localization and feature extraction and finally hamming distance based matching method.

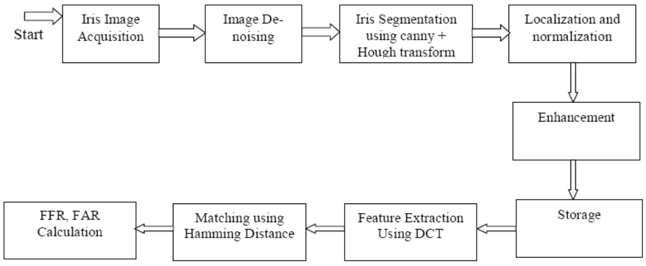

Figure 2: IRIS Recognition System Investigate

3.1 Iris Segmentation and Normalization

Following figure 3 showing the segmentation process used for this paper.

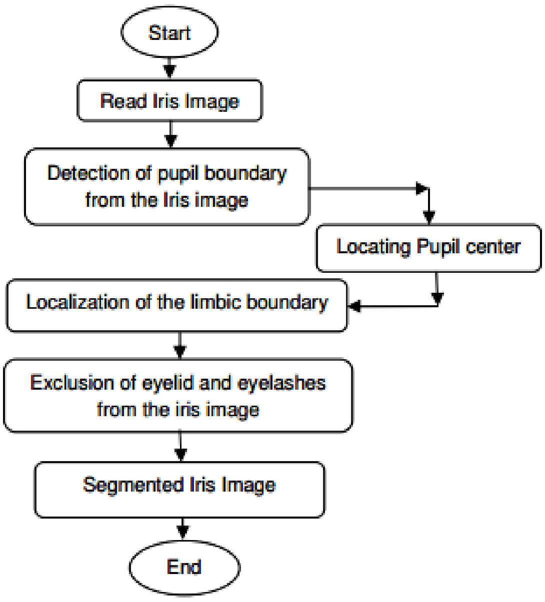

Figure 3: Research Design of Iris Segmentation

Algorithm 1: Improved method of pupil boundary detection.

Step 1: Convert the grayscale image into the binary image using the global threshold in order to segment pupil. Based on the image space, this threshold computes the constant of the threshold; transforming an image f to a binary image g as thus

$$g(x,y) = \begin{cases} 1 & \text{if } f(x,y) \geq T \\ 0 & \text{otherwise} \end{cases}$$

T is the threshold value.

Step 2: Inversion of the dark colour pupil to white to make it visible since it is the area of interest.

Step 3: Smoothen the blurred circular boundary of the pupil image by applying averaging filter for easy detection of the pupil boundary.

Step 4: Find the center of the Pupil by using Algorithm 2

The pupil center is located using the following procedure:

Algorithm 2: Method for finding the center of pupil.

Step 1: Scan through the binary image starting from the top left horizontally, using 8 marks the first and last 8-neigbour encountered whose value is 1 that should form a vertical bisector of the pupil circle at 0∘ and 180∘ respectively.

Step 2: Scan vertically through the image this time, using the same connected component in the same direction, also mark the first and last 8-neighbour encountered whose value is 1 that should circle at 270∘ and 90∘ respectively.

Step 3: Connect these two opposite point; whose midpoint half of the length of the opposite connected pixel is an assumed radius of the pupil.

Step 4: Use the assumed center and radius detected to localize the pupil circular shape.

Algorithm 3: Method of Detecting Iris Boundary

Step 1: Remove the noise on the eye image by applying minimal blurring to avoid making the boundary difficult to visualize.

Step 2: Apply 5 by 5 average filter for smoothing the image on the original intensity image.

Step 3: Feed the pupil center parameter as detected in section 3 to circle Hough transform to detect the iris boundary.

Algorithm 4: Detection and Removal of the Eyelids Algorithm

Step 1: Apply canny edge operator on the eye image

Step 2: Locate four different edge point pixels on the top (left and right) and bottom (left and right) respectively lying on the edge map of the eyelids detected by canny edge operator.

Step 3: Use the center of the pupil which is also the center of the iris, to locate the curvilinear eyelids shape and excluded it from the iris.

Algorithm 5: Detection and Removal of the Eyelashes

Step 1: Search for pixel values that are lower than the iris pixel values at the top and bottom of the iris image.

Step 2: Set the pixel values to the same value of the iris pixels in the neighborhood.

Step 3: Repeat the two steps above until all the eyelashes on this area are detected and removed, thus getting rid of the eyelashes.

3.2 Feature Extraction

Fourier-based iris coding work , it is start from a general paradigm where by the feature vectors will be derived from the zero crossings of the differences between 1D DCT coefficients calculated in rectangular image patches, as illustrated by Fig.4. Averaging across the width of these patches with appropriate windowing helps to smooth the data and mitigate the effects of noise and other image artifacts. This then enables us to use a 1D DCT to code each patch along its length, giving low-computational cost. The

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selection of the values for the various parameters was done by extensive experimentation over the CASIA and Bath databases to obtain the best predicted Equal Error Rate (EER). The two data sets were used in their entirety to optimize the parameters of the method.Experimentally overlappinging patches gave the best EER in combination with the other parameters. It was also found that horizontally aligned patches worked best, and a rotation of 45 degrees was better than 0 degrees or 90 degrees. This distinctive feature of our code introduces a blend of radial and circumferential texture allowing variations in either or both directions to contribute to the iris code. The DCT is a real valued transform, which calculates a truncated Chebyshev series possessing well-known minimax properties and can be implemented using the Discrete Fourier Transform (DFT).

Experimentally overlappinging patches gave the best EER in combination with the other parameters. To form image patches, we select bands of pixels along 45 degree lines through the image. A practical way of doing this is to slew each successive row of the image by one pixel compared to its predecessor. Patches are then selected in 11 overlapping horizontal bands as in Figure 4.

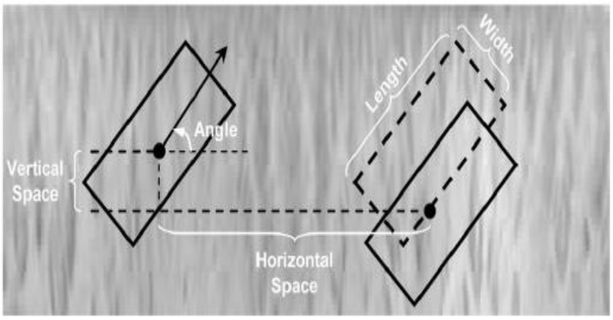

Figure 4: Overlapping angular patches with their various parameters.

The differences between the DCT coefficients of adjacent patch vectors are then calculated and a binary code is generated from their zero crossings.

3.3 Matching

For comparing two iris codes, a nearest-neighbor approach is taken, where the distance between two feature vectors is measured using the product-of-sum (POS) of individual subfeature Hamming distances (HD) [2]. This can be defined as follows:

$$HD = \left(\prod_{i=1}^{M} \frac{\sum_{j=1}^{N} \left(SubFeature\ 1_{ij} \oplus SubFeature\ 2_{ij} \right)}{N} \right)^{1/M}.$$

Here, we consider the iris code as a rectangular block of size MxN, M being the number of bits per subfeature and N the total number of subfeatures in a feature vector. Corresponding subfeature bits are XORed and the resultant N-length vector is summed and normalized by dividing by N. This is done for all M subfeature bits and the geometric mean of these M sums give the normalized HD lying in the range of 0 to 1. For a perfect match, where every bit from Feature 1 matches with every corresponding bit of Feature 2, all M sums are 0 and so is the HD, while, for a total opposite, where every bit from the first Feature is reversed in the second, MN/Ns are obtained with a final HD of 1 [2]. Since a total bit reversal is highly unlikely, it is expected that a random pattern difference should produce an HD of around 0.5.

IV. EXPERIMENTAL RESULTS

We have simulated above techniques of IRIS recognition using the different kinds of images from the CASIA dataset. We have implemented all above stated algorithms for this paper. Following figure 1 shows the main GUI of our simulation work done in MATLAB.

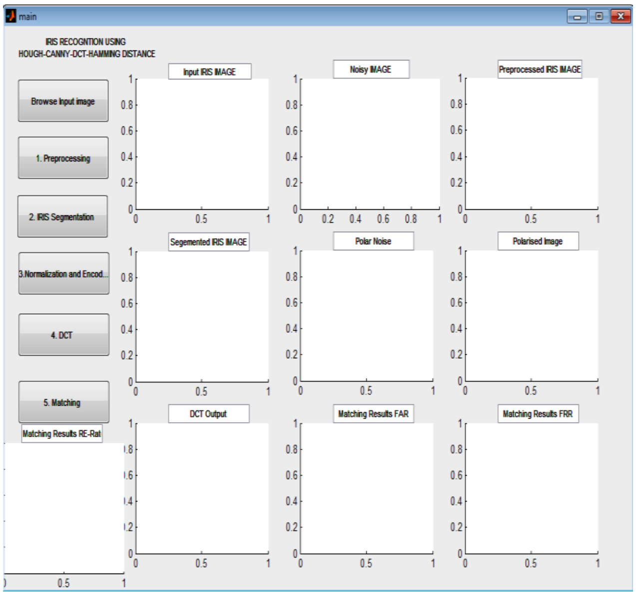

Figure 5: Main screen of Iris Recognition system

This process shows the how iris recognition system included the different methods step by step. We have calculated the performance of these techniques in terms of FAR (False Acceptance Rate) and FRR (False Rejection Rate).

The **FAR** or False Acceptance rate is the probability that the system incorrectly authorizes a non-authorized person, due to incorrectly matching the biometric input with a template. The FAR is normally expressed as a percentage, following the FAR definition this is the **percentage of invalid inputs which are incorrectly accepted**.

The **FRR** or False Rejection Rate is the probability that the system incorrectly rejects access to an authorized person, due to failing to match the biometric input with a template. The FRR is normally expressed as a percentage, following the FRR definition this is the **percentage of valid inputs which are incorrectly rejected**. FAR and FRR are very much dependent on the biometric factor that is used and on the technical implementation of the biometric solution.

Following figure 6 and 7 shows are finalized results for all this techniques and showing the improved results for FRR and FAR in case of two different images.

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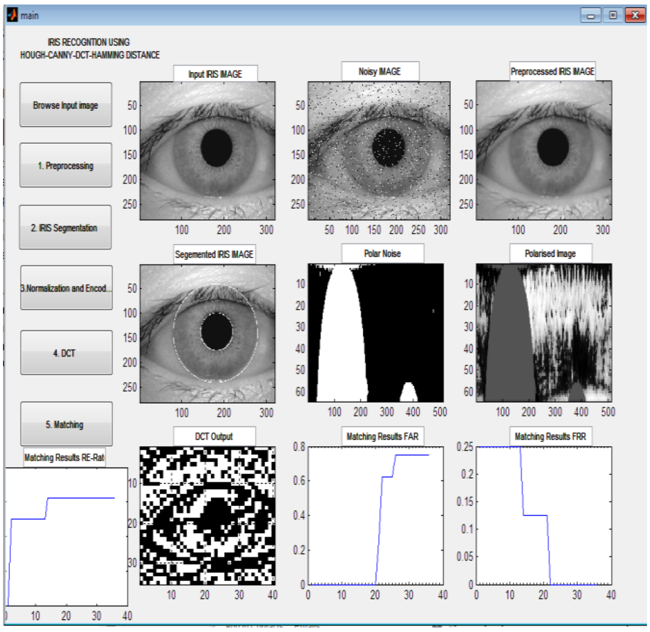

Figure 6: Iris Recognition System Results with image 1

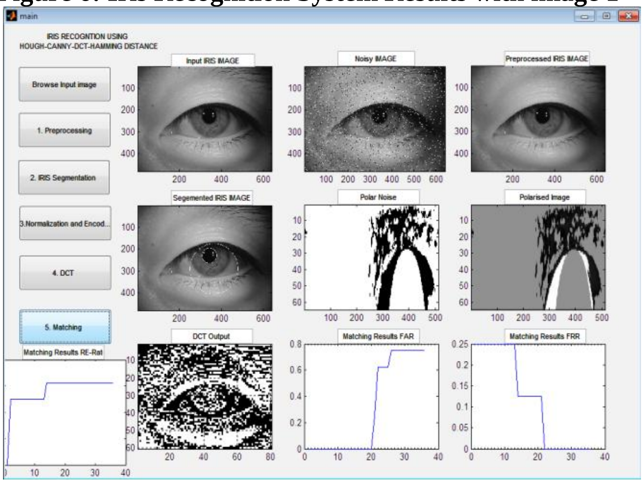

Figure 7: Iris Recognition System Results with image 2

Finally following table 1 shows that how this proposed methods of Iris Recognition is more accurate as compared to previously presented methods.

Number	Name Author/Method	Accuracy Rate
1	Seyyed M. T et al 2010 [8]	98.20 %
2	Chirayuth S. and Somying T. 2009 [9]	92.44 %
3	Proposed Method presented in This paper	98.95 %

Table 1: Performance of Accuracy

V. CONCLUSION

In the Iris Recognition, segmentation process is vital part by considering the performance and hence this much important phase of Iris Recognition System. As we studied in literature, previously few methods were presented for segmenting the Iris image, however those are vulnerable for certain limitations. In this paper we have investigated one such improved method for iris segmentation which is based on the use of Canny edge detection and Hough transform. These methods resulted into more accuracy as showing in table 1 above in results section. After that for features extraction we have used the well know 1D Discrete Cosine Transform (DCT). The use of DCT resulted into more improved performance. All the features extracted are stored into the mat files for all images datasets. Later finally during the matching process we have used Hamming Distance (HD). And hence all the features are compared against the input iris image. Based on this we have calculated the above results for FFR, FAR and Accuracy Rate.

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