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HYBRID TECHNIQUE OF IRIS RECOGNITION AND IRIS TEMPLATE MATCHING USING DAUGMANS AND GABOR WAVELET MODELS

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Abstract- Iris recognition is the process of recognizing a person by analyzing the random pattern of the iris. Iris scan biometrics employs the unique characteristics and features of the human iris in order to verify the identity of an individual. The iris is the area of the eye where it is pigmented or color circle, usually brown or blue. Iris recognition systems use small, high-quality cameras to capture a black and white high-resolution photograph of the iris. This process takes only one two seconds are provide the details of the iris that are mapped, recorded and stored for future mapping.
The main objective of this algorithm is to detect and enhancing pupil detection for efficient and fast with less mathematical burden on system. To implement efficiently even though upper portion of the eye is densely covered by eyelashes. To improve overall performance of the system and achieve accuracy with minimized execution time compare than the existing methods. Iris recognition processing generally consists of the following steps: (i) Image acquisition (ii) Iris segmentation and (iii) Normalization. In this algorithm implemented, segmentation was achieved using the Hough transform for localizing the iris and pupil regions. The segmented iris region was normalized to a rectangular block with fixed polar dimensions using Daugman's rubber sheet model.

Keywords: Daugman's rubber sheet model, Segmentation, Iris recognition, Normalization.

1. INTRODUCTION

A biometric system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. A good biometric is characterized by use of a feature that is; highly unique, so that the chance of any two people having the same characteristic will be minimal, stable, so that the feature does not change over time, and be easily captured, in order to provide convenience to the user and prevent misrepresentation of the feature. The human iris is best suitable for this application. Iris recognition is a method of biometric authentication that uses pattern-recognition techniques based on high-resolution images of the irises of an individual's eyes. Here, person‟s eye image is captured (Data Acquisition), the iris region is separated from the rest of the eye image (Segmentation), this iris region is processed to allow comparisons with existing database (Normalization and Enhancement). Robust representations for pattern recognition must be invariant to changes in the size, position, and orientation of the patterns. In the case of iris recognition, this means must create a representation/template that is invariant to the optical size of the iris in the image (which depends upon the distance to the eye, and the camera optical magnification factor); the size of the pupil within the iris (which introduces a nonaffine pattern deformation); the location of the iris within the image; and the iris orientation, which depends upon head tilt, torsional eye rotation within its socket (cyclovergence) and camera angles, compounded with imaging through pan/tilt eye-finding mirrors that introduce additional image rotation factors as a function of eye position, camera position, and mirror angles. For this, segmented iris region should be converted into dimensionally consistent representation of the iris region. Iris normalization strategies evaluated and implemented to remove dimensional inconsistencies in order to produce normalized iris template [1-6]. Some modifications are proposed for the existing techniques to achieve optimized results. The main objective of this paper is to implement iris image segmentation and Iris normalization techniques and find the best suitable approach by comparing them.

II. Existing System

A large part of it is based on the detailed survey that Bowyer et al. have written on iris recognition in 2008 [14]. In addition, emphasize on the methods authors have proposed to handle the degraded quality of iris images for recognition. This will lead us to point out what contribution this doctoral work makes in the management of the issue of degraded iris images.

The idea of using the iris as a biometric modality was suggested by A. Bertillon in 1885 [8], long before the first biometric system was built. Then in 1987, two ophthalmologists, Flom and Safir proposed a conceptual design of an automatic iris biometric system and obtained a patent [30]. An investigation of the feasibility of iris biometrics was conducted a few years later by Johnston at Los Alamos National Laboratory in 1992 [4] and it was concluded that iris biometrics held potential for both verification and identification.

Daugman was the first author to propose an operational iris recognition system in 1993 [7]. In this system, Gabor filters are used to generate a binary code representing the iris. Irises are then compared by an efficient comparison of their binary codes using bitwise operations. Later on, many authors have looked at alternate ways to generate a binary code. Others have chosen to represent the iris by a real-valued feature vector.

Krichen also integrates a local quality measure in the calculation of the similarity score of his correlation-based algorithm: the local correlations of sub-images are weighted by the minimum quality of the sub-images in the computation of the global similarity score, also uses local quality measure to compute a weighted Hamming distance, similarly to Chen et al.

III. Hybrid Model of DG

DG is nothing but , it is the hybrid technique of Daugmans and Gabor Wavlet Model. This two Classes are implemented and combined into one function. Input argments are the iris and database are extracted by using the MMUIris. The Iris acquisition of the eye image is captured. Then the segmentation steps the iris region image is located. Then dimensionally consistent representation of the iris region is created during the time of normalization.

Input: Eye image

Output: Iris Recognition of a person

(a) Read the eye image.

(b) Iris segmentation using Hough Transformation. In this step segmentation of two circles are utilized to separate between (iris or sclera boundary) and (iris or pupil boundary). Each iris with the combination of either darkly pigmented display or otherwise low contrast between the pupil and iris region. If the image is acquired under natural light, it is very difficult to segment the particular portion. But proposed algorithm to overcome these difficulties.

(c) Iris normalization using Daugman's model. This normalization method to produce different iris regions for different iris using different condition. Daugman's model remap model used to convert from the original cartesian coordinates into normalized polar coordinates.
(d) Running time calculation

- **Iris Image Dataset**
  The iris image in MMUIris database was used to evaluate this algorithm. Now the database belongs to one of the publicity available largest iris datasets.
- **Pre-processing**
  The acquired image always contains not only useful parts but also some parts which are not useful for further work. Under some conditions the brightness is not uniformly distributed. In addition, different eye -to camera distance may result in different sizes of the same eye. For the purposen of analysis the original image needs to be processed.
- **Segmentation**
  Iris segmentation was used to isolate the actual iris region from a digital eye image. The iris region, can be bounded by two circles pertaining to the pupil (inner boundary) and sclera (outer boundary). Segmentation is one of the best automated (and possibly manually reviewed) detection of the iris-sclera and iris-pupil boundaries. This localizes the iris texture that is used for actual recognition. In segmentation method, two circles are used to separate between iris boundary, sclera boundary and iris boundary, pupil boundary. The eyelashes and eyelids normally obstruct the upper and lower parts of the iris region.

The success of a segmentation method depends upon the quality of eye images. An individual with darkly pigmented irises displays a low contrast between the pupil and iris region if the image is acquired under natural light, making segmentation more difficult. To overcome the difficulties used Circular Hough Transformation.

3.1 Circular Hough transformation

The Circular Hough transformation is an automatic segmentation method. It is generally used to compute the parameters of the geometric objects such as lines and circles in an eye image. For identifying the center coordinates and radius of the iris and pupil regions, the circular Hough transform can be used. This method generally uses a voting technique to locate or identify the shapes of an objects within the classes available. The Hough segmentation algorithm firstly creates an edge map by computing the gradients or first derivatives of intensity values in an eye image. For each edge pixel in the edge map, the surrounding points on the circle at various radii are taken, and votes are cast for finding the maximum values that constitute the parameters of circles in the Hough space [4].

The center coordinates x_c and y_c the radius r which are able to define any circle according to the below equation (1) .

$$x_c^2 + y_c^2 - r^2 = 0 \qquad (1)$$

The parabolic Hough Transform to detect the eyelids, approximating the upper and lower eyelids with parabolic arcs, which are represented as the below equation (2)

$$(-(x-h_j)\sin\theta_j + (y-k_j)\cos\theta_j)^2 = a_j((x-h_j)\cos\theta_j + (y-k_j)\sin\theta_j) \qquad (2)$$

Where, the controls the curvature is a_j, the peak of the parabola is (h_j, k_j), the angle of rotation relative to the x-axis is θ_j.

The Daugman findings are used for locating the circular iris and pupil regions and also the arcs of the upper and lower eyelids. The differential operators are defined as

$$\max_{(r,x_p,y_e)} |G_\delta(r) * \frac{\partial}{\partial_r} \oint_{x_0,y_0} \frac{I(x,y)}{2\pi r} d_s | \tag{3}$$

The eye image is defined as $I(x,y)$ and the radius r, then Gaussian smoothing function is $G_\delta(r)$. And 's' is the contour of the circle given by r, x_0, y_0. The operator searches for the circular path where there is maximum changes in pixel values, by varying the radius and the centre x and y position of the circular contour. The active contour models for localizing the pupil in eye images. Pre-set internal and external forces are responded with active contours. The active contours respond by deforming internally or moving across an image. Execute the process continuously unlit reaches the equilibrium stage. The contour includes some vertex, these vertices have positions that are changed by two opposing forces one is internal force and another one is external force. The internal force is depending on the desired characteristics and the external force is depends on the image. Each vertex is moved between t and by $t+1$

$$V_i(t+1) = v_i(t) + F_i(t) + G_i(t) \tag{4}$$

The F_i is defined as internal force, G_i is external force, the position of vertex i is V_i. For localization of the pupil region two forces are used, initially apply internal forces are calibrated so that the contour forms a globally expanding discrete circle. Then next external force usually found using the edge information.

When performing the edge detection, considered derivatives/gradients in the vertical direction to detect the iris-sclera boundary to decrease the effect of the eyelids which are horizontally aligned [2]. The vertical gradients are taken for locating the iris boundary and to reduce the influence of the eyelids. When performing circular Hough Transformation, not all of the edge pixels that define the circle are required for successful localization. Not only does this make circle localization more accurate, but it also makes it more efficient, since there are fewer edge points to cast votes in the Hough space [3].

In Circular Hough Transformation to ensure the iris detection is efficient and accurate, boundary between iris and sclera circle is detected in iris region. In whole eye region, the pupil is always within the iris region.

3.2 Normalization

Once the segmentation module has estimated the iris's boundary, the normalization module uses image registration technique to transform the iris texture from cartesian to polar coordinates. The process, often called iris unwrapping, yields a rectangular entity that is used for subsequent processing. Iris Normalization use only the lower half of the iris region.

Eyelid is not necessary for recognition.

Using the same method for detecting the inner boundary, detect the eyelid boundary.

Normalization has three advantages:

It accounts for variations in pupil size due to changes in external illumination that might influence iris size.

It ensures that the irises of different individuals are mapped onto a common image domain in spite of the variations in pupil size across subjects.

It enables iris registration during the matching stage through a simple translation operation that can account for in-plane eye and head rotations.

Associated with each unwrapped iris is a binary mask that separates iris pixels (labeled with a "1") from pixels that correspond to the eyelids and eyelashes (labeled with a "0") identified during segmentation. After normalization, photometric transformations enhance the unwrapped iris's textural structure.

3.3 Iris Normalization

In normalization, iris region is transformed so that it has fixed dimensions to allow comparison between same iris images. The inconsistencies between same eye images are due to stretches of the iris caused by dilation of pupil from different illumination. Among other factors that cause dilation are, eye rotation, camera rotation, head tilt and varying images distance. The good normalization process must produce constant dimensions for the same iris in different condition. Another great challenge is that the pupil region is not always concentric within the iris region, and is usually slight nasal[9].

Daugman's rubber sheet model explains remap of each iris regions point to the polar coordinates (r,θ)

The distance $[0,1]$ is: r
The angle $[0,2\pi]$ is: θ

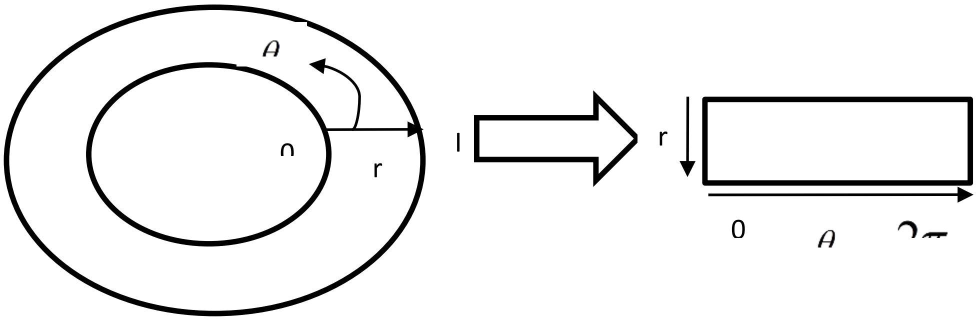


Figure 1. Daugman's rubber-sheet model used for iris normalization.

The circular shape represents segmented iris region and the rectangular shape represents normalized iris which is equivalent to the segmented iris region. The remapping of the iris region from (x,y) Cartesian coordinates to the normalized non concentric polar representation is modeled as

To change the iris shape which is represented by zigzag collarette circular area into a rectangular shape. [4] proposed normalization iris to reduce inconsistencies due to improper iris acquisition by converting to polar form, the method used is called the Daugman Rubber Sheet Model. In this experiment used the formulation Daugman Rubber Sheet Model to map the zigzag collarette into polar form as follows:

$$I(x(r,\theta),y(r,\theta)) \rightarrow I(r,\theta) \quad (5)$$

With

$$x(r,\theta)=(1-r)x_p(\theta)+rx_1(\theta) \quad \text{and } (6)$$

$$y(r,\theta)=(1-r)y_p(\theta)+ry_1(\theta) \quad (7)$$

Where iris region image is defined as $I(x,y)$ original Cartesian coordinates are (x,y), normalized polar coordinates are (r,θ). Where $x_p(\theta)$ is the coordinates of the x-axis pupil boundary, $y_p(\theta)$ is the coordinates of the y-axis pupil boundary, $x_1(\theta)$ is the coordinates of the x-axis zigzag collarette boundary, $y_1(\theta)$ is the coordinates of the y-axis zigzag collarette boundary. The interval radius is [0,1] and interval angle is $[0,2\pi]$.This implies that the radius of zigzag collarette has a length of 1 unit while the radius pupil converted into units acquired

$$\hat{r}_p = \frac{r_p}{r_p+24} \quad (8)$$

where r_p is the radius of the pupil in pixels.
To find the length and width of a pixel on polar coordinates the below steps are follwed in normalizing zigzag collarette:
Find the length and width of a pixel on polar coordinates M and N. Here M is represented as width of the pixel and N is represented as length of the pixels.
Calculate the difference of the radius value by using the below equation (9)

$$\Delta r = \frac{\hat{r}_z - \hat{r}_p}{M-1} \qquad (9)$$

Calculate the difference of angle value by using the below equation (10)

$$\Delta\theta = \frac{2\pi}{N} \qquad (10)$$

Remapping of each pixel in accordance with the size of radius $\hat{r}_p + \Delta r$ and angle .
The output obtained show that the normalization process goes well and can map each pixel zigzag collarette to a rectangular shape.

3.4 Gabor Technique

The iris recognition using pair wise distance, this computes the Hamming distance. This will Reduce the value of FAR, FRR AND EER and Increasing the TSR thus increasing the overall efficiency.

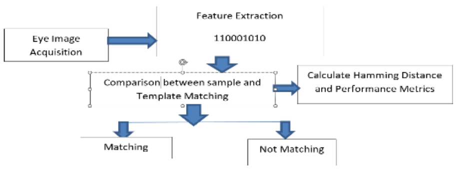


Figure.2 Hybrid Feature Extraction and Recognition

Transformation of images: The interior and superior cones of iris images are removed. The size difference of the iris are recompensed using an image polar sampling, obtaining J as a result. The below equation(11) used to calculate the transformation

$$J(\rho, \phi) = I_E(x_0 + r\cos\theta, y_0 + r\sin\theta) \qquad (11)$$

IV. Implementation Results

Images of MMUIris (800 × 600) database [8]. MATLAB (R2021) is used as the development tool. The computer system used has Intel Pentium 4 CPU, 3.06 GHz, 0.99 GB RAM. For the performance evaluation of the proposed approach, the image is taken from MMUIris image database version 1 available at [8]. In which for the experiment, the below tables are shows the various stages of Iris recognition method. The Input images are used from the database, then the input images are converted into localized image by using the appropriate method. Then next stage segment or extract the exact portion of Iris image from the localized output. Also find the normalization output. This proposed algorithm successfully designed and executed for the purpose of Biometric identification in various current requirements. Running time calculation is very less compare than the existing algorithms.

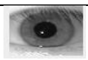
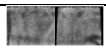
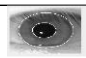
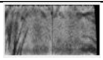
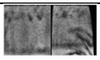
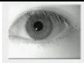
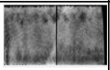
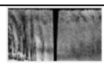
S. No	Input image	Localized Image	Dauman's operator	Normali-zation	output
Iris_1					
Iris_2					
Iris_3					
Iris_4					
Iris_5					

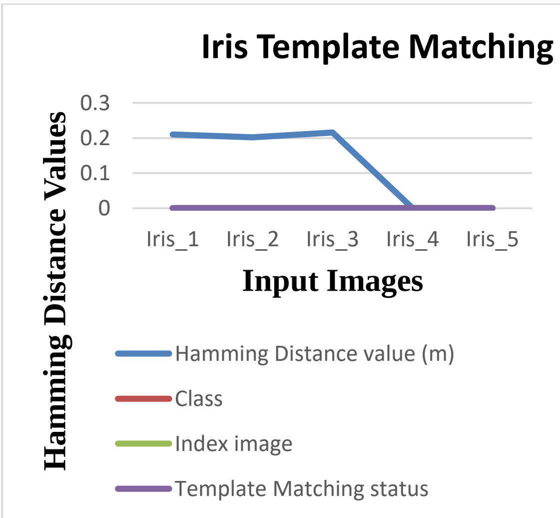
Table 1. Running Time Calculation

S.NO	Localized Image Running Time(s)	Dauman's operator Running Time(s)	Proposed method Running Time(s)
Iris_1	0.0551	6.5040	0.3205
Iris_2	0.0083	6.0320	0.1969
Iris_3	0.0058	5.5515	0.2283
Iris_4	0.0059	5.6211	0.1937
Iris_5	0.0056	5.3960	0.1902

Table 2. Output for Iris Recognition

4.2 Hamming Distance values and Template Matching

S.NO	Hamming Distance value (m)	Class	Index image	Template Matching status
Iris_1	0.21	Left1_1	Right1_4	Not Matching
Iris_2	0.202	Left2_2	Right2_5	Not Matching
Iris_3	0.216	Left3_3	Right3_1	Not Matching
Iris_4	0.00	Left4_4	Left4_4	Matching
Iris_5	0.00	Left5_5	Left5_5	Matching



V. CONCLUSION

Iris is denoted biometric representation of an individual for security related applications. The iris segmentation and iris normalization process is challenging due the presence of eye lashes that block the iris, the dilation of pupils due to different light illumination and various uncontrolled factors. In this algorithm to locate the iris and normalized the image, also convert the image from polar coordinate into cartesian coordinate. The running time of this algorithm is less compare than the existing algorithms.

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