



Iris Recognition System using Gabor Filter

Updesh Kumar Jaiswal¹.

Navin Pratap Singh Rathore², Shubhankar Thakur³, Atisha Singh⁴

^{2,3,4}IMS Engineering College (IMSEC), National Highway 24, Near Dasna,
Adhyatmik Nagar, Ghaziabad, Uttar Pradesh 201009, INDIA.

Abstract: Iris feature extraction is a significant process in iris biometric process. It is a technological system that uses information about a person to identify that person. These systems rely on specific data about unique biological traits in order to work effectively such as finger print, facial recognition, voice recognition etc. Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on images of one or both of the irises of an individual's eyes whose complex patterns are unique, fixed and can be seen from some distance.

Keywords: Segmentation, Normalization, Feature extraction, 1-D Gabor Filter, Edge detection.

I. Introduction

Nowadays biometric systems are becoming famous for personal identification. The uniqueness in the iris pattern makes it a robust technique for identification of a person. The steps involved in iris recognition are:

Segmentation: Detection of inner and outer boundary of the iris.

Normalization: Conversion of iris from Cartesian form to polar form takes place.

Feature Extraction: Extract the unique feature vector.

Matching: Here comparison of iris processed template with the other template stored in database.

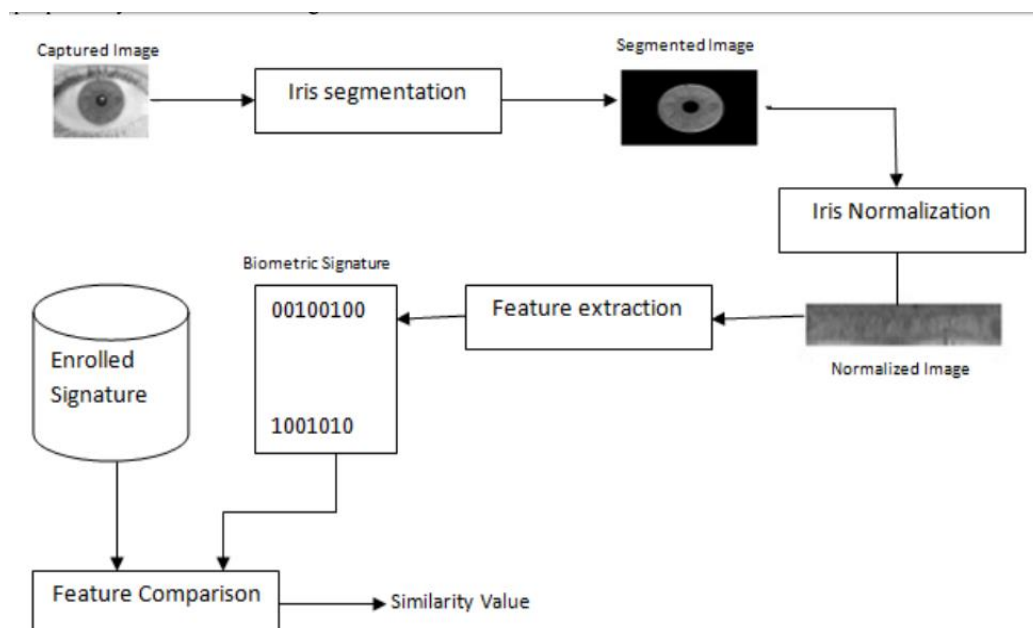


Figure 1: Model

II. Segmentation

Segmentation is the process of partitioning an image into set of pixels. Eye can be approximated by two circles, one for iris and another for pupil boundary. The output of segmentation is an iris signature. The Hough Transform can be used to determine the parameters of simple geometric objects, such as line, circle and parabola.

The circular Hough Transform is used to infer the radius & center coordinate of pupil & iris regions.

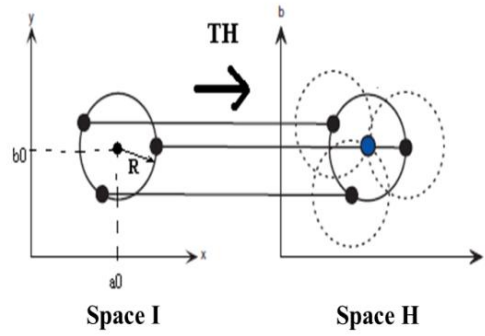


Figure 2

Let us consider a circle of radius R and center (a_0, b_0) , the transformation for each point (x_i, y_j) in space I yields a circle in space H having a center x_i, y_j and radius R .

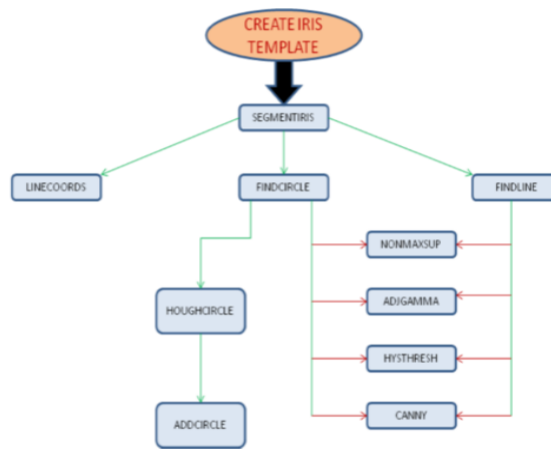


Figure 3: Functions Used In Segmentation

A. Functions

Segmentiris: Isolates noise areas such as eyelids and eyelashes.

Findcircle: Returns the coordinates of a circle in an image.

Linecoords: Returns the x y coordinates of positions along a line.

Findline: Returns the coordinates of a line in an image.

Houghcircle: Performs the Hough transform for finding circles in the image.

Addcircle: A circle generator for adding weights into a Hough accumulator array.

Nonmaxup: Function for performing non-maxima suppression.

Ajdgamma: It adjust image gamma.

Hysthresh: This function performs hysteresis threshold of an image.

Canny: Used to perform canny edge detection

B. Daugman's integro differential operator

Now, locate the circular iris and pupil regions and also the arcs of the upper and the lower eyelids. The operator searches for the circular path where there is maximum change in pixel values by varying the radius and centre x and y position of the circular contour to achieve precise location of eyelids.

$$\max_{r, x_0, y_0} \left| G_\sigma(r) * \frac{\delta}{\delta r} \oint_{r, x_0, y_0} \frac{I(x, y)}{2\pi r} ds \right|.$$

Where, $I(x, y)$: Eye Image

r : Radius

$G(r)$: Gaussian smoothing function and the contour of the circle.

III. Normalization

The process of normalization is done to transform the cartesian coordinates of the iris image into its polar form. The iris image has variations which involve illuminations that directly affect the size of pupil thus causes non-linear variations, in cartesian coordinates the iris images are also affected by the distances and angular position with respect to the camera. A typical normalization technique should reimburse these variations. To perform the normalization we will use Daugman's Rubber sheet model. It is used for compensating unwanted factors.

A. Functions Used In Normalization

Normaliseiris: Normalization of the iris region by unwrapping the circular region in a rectangular block.

Encode: It generate a biometric template.

Gaborconvolves: Used for convolving each row of a image with 1D log-gabor filter.

B. Daugman's Rubber sheet model

In this model, a reference point is considered. This reference point is the center of the pupil. A remapping formula is used to accomplish the task of converting the points on Cartesian scale to the polar scale.

$$r' = \sqrt{\alpha\beta} \pm \sqrt{\alpha\beta^2 - \alpha + r_1^2}$$

where r_1 = iris radius

$$\alpha = O_x^2 + O_y^2$$

$$\beta = \cos\{\pi - \arctan\left(\frac{O_y}{O_x}\right) - \theta\}$$

The radial resolution is set to 100 and angular resolution is set to 2400 pixels. Each pixel of iris image has some position on the polar axes. Now the normalized image is transcluded into the size of actual image, by using interp2 function. The parts of the normalized image which gives NaN, are divided by the sum to get a normalized value.

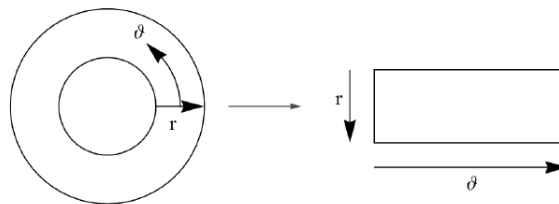


Figure 4

IV. Feature Extraction

The method used for feature extraction uses –

-wavelet transform

-Gabor filter

Wavelet Transform : It is a function having discontinuous and sharp peaks.

For the eyelashes detection ,1-D Gabor filter is used and also for removing the noise from the iris preprocessed image.

Steps in 1-D Gabor filter are:

Step 1: Gabor wavelet

$$G(x,y) = S(x,y) W(x,y)$$

Complex carrier in the form:

$$S(x,y) = ej(2\pi ux+vy +P)$$

Step 2: Real part:

$$\text{Re}(s(x,y)) = \cos[f_0] (2\pi ux+vy +P)$$

Imaginary part:

$$\text{Im}(s(x,y)) = \sin[f_0] (2\pi ux+vy +P)$$

u & v are the frequencies of horizontal & vertical sinusoidal

P is arbitrary phase shift.

Using gabor filter

- Calculate Gabor radial filter component
- Extract feature vector

- For each row do the convolution & back transformation

V. EDGE DETECTION

Edge Detection is used to detect the local change of intensity in an image. Edge operators are tender to horizontal edges, vertical edges or both. It returns a image containing binary 1's where edges are found and binary 0's elsewhere. Here our goal is to produce drawing instance corners, lines, curves and points in order to extract the key feature or key information.

There are three edge operators used :

-canny
-sobel
-prewitt

Canny is an optimal edge detector. It convolves the image with the derivative of Gaussian for smoothing the image.

The input is grayscale image and output image is showing the positions of tracked intensity discontinuities.

Sobel uses the image with a separable and integer valued filter in horizontal and vertical direction. It uses 3x3 kernels convolved with original image.

G_x and G_y are reference and sample iris features.

$$G = \sqrt{G_x^2 + G_y^2}$$

Gradient Magnitude:

Prewitt is a discrete differential operator. It compute an approximation of the gradient of image intensity.

I_x :Is the gradient magnitude for horizontal approximation.

I_y :Is the gradient magnitude for vertical approximation.

$$I = \sqrt{I_x^2 + I_y^2}$$

Iris Feature :

VI. MATCHING

In this process the iris template is compared with the iris image from the database for recognition.

Techniques used in edge detection are:

- 1.Hamming Distance
- 2.Weighted Euclidean distance
- 3.Normalized correlation

Weighted Euclidean distance and Normalized correlation has lots of calculation. Hamming distance is more fast and simple matching technique.

Hamming Distance is calculated as:

Difference between bits of two iris template/Length of vector

VII. Proposed Approach

A. Feature Extraction Stage using Lifting Wavelet Transform

In order to provide accurate recognition of individuals, only the most significant features must be encoded so that templates can be compared. The iris template has been divided into 20X20 blocks and Lifting Wavelet transform is applied to each block. Each block is divided into 4 sub bands denoted by LL, LH, HL, and HH.

$FP(u,v)=LWT(P(u,v))$

where $FP(u,v)$ and $P(u,v)$ are the transform and pixel data respectively. The transform data is normalized by calculating the sum of the squared values of each magnitude component (except the zero frequency components), so that the magnitude data is invariant to shifts in illumination. Normalization coefficients are given by NFP.

The transformed data is then described by energy, e . This measure is immune to rotation and is scale constant. Some other measures such as energy in the major peak, Laplacian of the major peak, entropy, inertia, largest horizontal frequency and largest vertical frequencies can also be considered as the features. Energy is computed for the iris template using the formula.

The size of each template is 20x240. Each template has been divided into 12, 20x20 blocks and each 20x20 block has been divided into 4 sub bands. Therefore a feature vector (by computing the energy) of size 1x48 is produced for each iris template. By repeating the procedure for the entire data set of the images, we get several energy feature vectors of length 1x48. In order to select significant features from the iris template, variance is

computed. To form a feature vector for each iris image, the energy values corresponding to the largest value is taken .

VIII. Result

An image of dimensions (320*280) with jpg extension is used to implement the work. The results obtained from segmentation and normalization processes are discussed below along with the figures. Figure 8.1: Shows the original iris image which is taken as input. This image will go through all the stages of iris recognition.

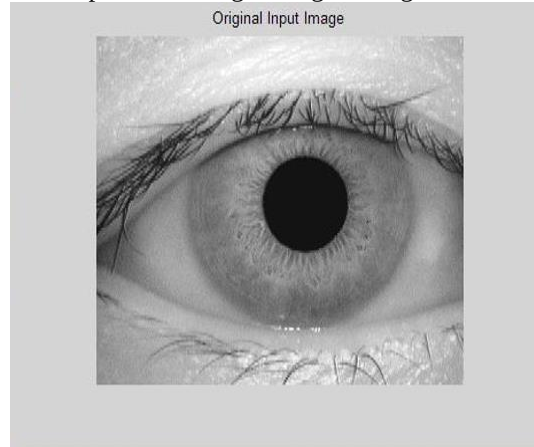


Figure 8.2: After taking the original image, the detection of pupil and iris boundaries is done. Hough circles are used to perform the detection. In the figure, the circles of white lines are the detected boundaries.

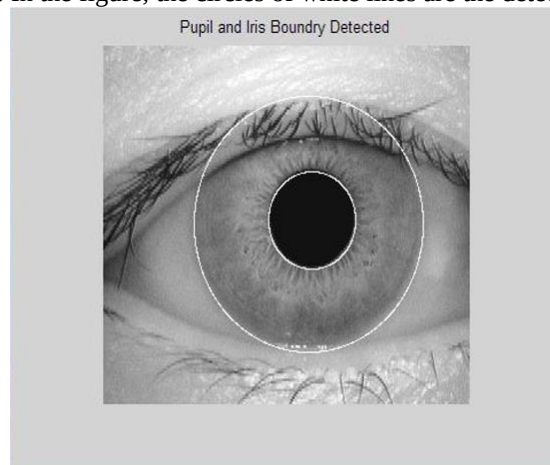


Figure 8.3: The edge of the eyelids and the iris is detected. For this we are using the application of canny edge detection.

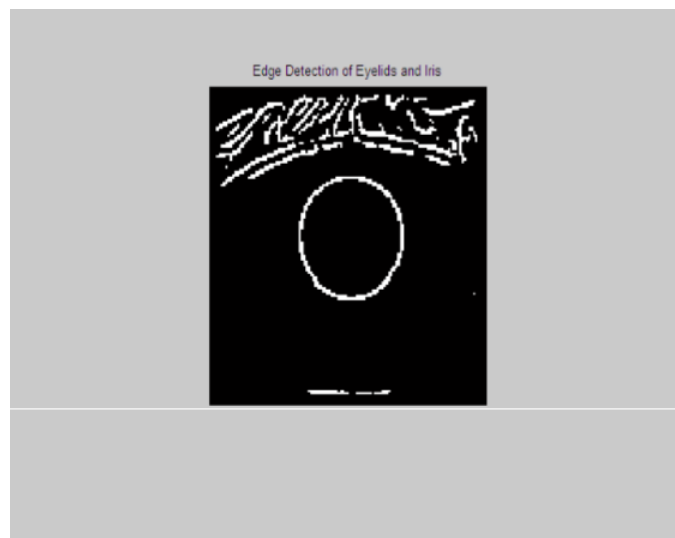


Figure 8.4: The top and bottom eyelid detection is done in this figure. The intruding eyelids are removed over the detected iris region and also the other variations which affect the iris region are eliminated to generate a good pattern for matching process.

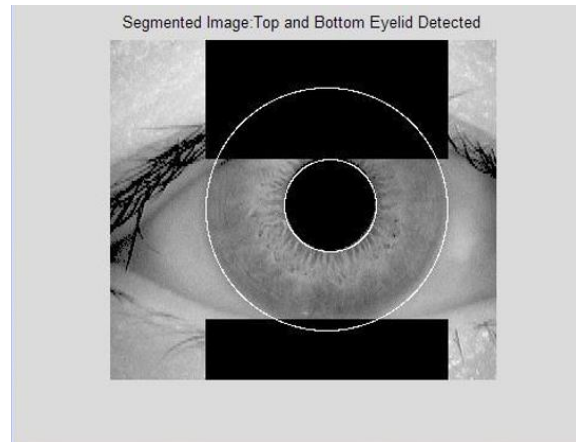


Figure 8.5: This figure has the normalized image which is produced after detection of pupil and iris boundaries along with top and bottom eyelid detection .



IX. Conclusions

The proposed method extracts both local and global details of the iris. Gabor filter technique is used to filter the iris image and eliminate the noise in the preprocessed image .By using hamming distance and euclidean distance ,the classification of iris templates is done. This will help to easily distinguish between persons by identifying their irises.

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