Analysis of Iris Images for Iris Recognition System

Anuradha Shrivas
Disha Institute of Management
&Technology, Raipur, India

Preeti Tuli
Department of Computer Science &
Engineering, Raipur, India

ABSTRACT

This paper proposes an iris recognition algorithm based on iris images. It consists of five major steps i.e., iris acquisition, localization, normalization, feature extraction and matching. The inner pupil boundary is localized using Circular Hough Transformation. The technique performs better in the case of occlusions and images muddled by artifacts such as shadows and noise. The outer iris boundary is detected by circular summation of intensity approach from the determined pupil center and radius. The localized iris image is transformed from Cartesian to polar co-ordinate system to handle different size, variation in illumination and pupil dilation. Corners in the transformed iris image are detected using covariance matrix of change in intensity along rows and columns. All detected corners are considered as features of the iris image. For recognition through iris, corners of both the iris images are detected and total number of codes that are matched between the two images are obtained. The two iris images belong to the same person if the number of matched corners is greater than some threshold value.

Keywords: Biometrics, Circular Hough transform, Hamming Distance.

1. INTRODUCTION

Iris is gaining lots of attention due to its accuracy, reliability and simplicity as compared to other biometric traits. The human iris is an annular region between the pupil (generally darkest portion of the eye) and sclera. It has many interlacing minute characteristics such as freckles, coronas, stripes, furrows, crypts and so on. These minute patterns in the iris are unique to each individual and are not invasive to their users. These properties make iris recognition particularly promising solution to society. Biometric solutions address the security issues associated with traditional method of Human Recognition is based on personal identification number (PIN),Id cards, Secret passwords etc., and the traditional methods face severe problems such as loss of identity cards and forgetting/ guessing the passwords. Biometric measures based on physiological or behavioral characteristics are unique to an individual and have the ability to reliably distinguish between genuine person and an imposter. The physiological characteristics include Iris, Finger Print, Retinal, Palm Prints, Hand Geometry, Ear, Face and DNA, while the behavioral characteristics include Handwriting, Signature, Body Odor, Gait, Gesture and Thermal Emission of Human Body. The biometric systems based on behavioral characteristics fail in many cases as the characteristics can easily be learnt and changed by practice. Some of the techniques based on physiological characteristics such as Face Recognition, Finger Prints and Hand Geometry also fail when used over a long time as they may change due to ageing or cuts and burns. Among all the biometric techniques Iris Recognition has drawn a lot of interest in Pattern Recognition and Machine Learning research area because of the advantages viz., (i) The Iris formation starts in the third month of gestation period and is largely complete by the eighth month and then it does not change after two or three years. (ii) The human Iris might be as distinct as the Finger Prints for the different individuals. (iii) The forming of Iris depends on the initial environment of the Embryo and hence the Iris Texture Pattern does not correlate with genetic determination. (iv) Even the left and the right Irises of the same person are unique. (v) It is almost impossible to modify the Iris structure by surgery. (vi) The Iris Recognition is noninvasive. (vii) It has about 245 degrees of freedom.

2. LITERATURE SURVEY

The concept of automated iris recognition has been initially proposed by Flom and Safir [1]. Daugman [2] has used multi-scale quadrature wavelets to extract texture phase structure information of the iris to generate a 2048 bit iris code and compared the difference between a pair of iris representations by computing their Hamming distance via the XOR operator. Boles and Boashash [3] have calculated zero-crossing representation of 1-D wavelet transform at various resolution levels of a virtual circle on an iris image to characterize the texture of the iris. Wildes et al. [4] have represented the iris texture with a Laplacian pyramid constructed with four different resolution levels and has used the normalized correlation to determine whether the input image and the model image are from the same class. This paper proposes an iris recognition algorithm which consists of five major steps. These steps are iris acquisition, localization, normalization, feature extraction and matching. The detailed image acquisition strategy is given in next section. Section 3 presents localization of inner pupil boundary using Circular Hough Transformation. The technique performs better in case of occlusions and images muddled by artifacts such as shadows and noise. Thus the inner pupil boundary can be detected without any sort of preprocessing required on the captured iris image. The outer iris boundary can be detected by circular summation of intensity approach from the known pupil center and radius. Section 4 deals with the normalization of the iris image. In this section iris image is transformed from Cartesian to polar co-ordinate system to handle different size, variation in illumination and other factors. Features are extracted from the normalized polar image in Section 5. The corner points are detected for the database and query images by using

covariance matrix and detected points are matched by using the hamming distance approach.

   Christel-Loïc Tisse et al examined a new iris recognition system that implements (i) gradient decomposed Houghtransform / integral-differential operators combination iris localization and (ii) the "analytic image" concept

(2D-Hilbert transform)

to extract pertinent information from iris texture. Li Ma et al proposed A new approach for a personal identification based on iris recognition. The body
of their papers details the steps of iris recognition, including image preprocessing, feature extraction and classifier design. The proposed algorithm uses a bank of Gabor filters
to capture both local and global iris characteristics to form a fixed length feature vector. Iris matching is based on the weighted Euclidean distance between the two corresponding iris vectors and is therefore very fast .Narayanswamy et al employs an especially designed Wave front Coded lens customized for iris recognition. They presented experimental results that show the benefits of this technology for biometric identification. Zhuoshi Wei et al presented a framework to synthesize large realistic iris databases, providing an alternative to iris database collection. Firstly, iris patch is used as a basic element to characterize visual primitive of iris texture, and patch-based sampling is applied to create an iris prototype.
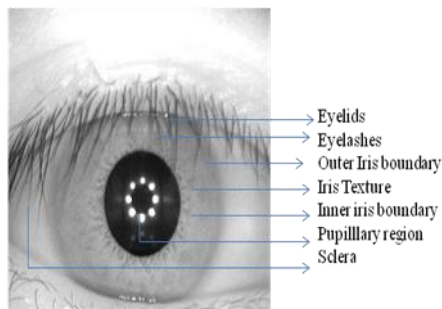

Figure1: Iris image

3. IMAGE ACQUISITION

The iris image should be rich in iris texture as the feature extraction stage depends upon the image quality. Thus, the image is acquired by 3CCD camera placed at a distance of approximately 9 cm from the user eye. The approximate distance between the user and the source of light is about 12 cm.
Here the work is based on Iris images taken from standard CASIA data base .

4. IRIS LOCALIZATION

The acquired iris image has to be preprocessed to detect the iris, which is an annular portion between the pupil (inner boundary) and the sclera (outer boundary). The first step in iris localization is to detect pupil which is the black circular part surrounded by iris tissues. The center of pupil can be used to detect the outer radius of iris patterns. The important steps involved are:
Pupil detection
Outer iris localization
Pupil Detection

The iris image is converted into grayscale to remove the effect of illumination. As pupil is the largest black area in the intensity image, its edges can be detected easily from the binarized image by using suitable threshold on the intensity image. But the problem of binarization arises in case of persons having dark iris. Thus the localization of pupil fails in such cases. In order to overcome these problems Circular Hough Transformation [6] for pupil detection can be used. The basic idea of this technique is to find curves that can be parameterized like straight lines, polynomials, circles, etc., in a suitable parameter space. The transformation is able to overcome artifacts such as shadows and noise. The approach is found to be good particularly dealing with all sorts of difficulties including severe occlusions [7].
The procedure first finds the intensity image gradient at all the locations in the given image by convolving with the sobel filters. The gradient images (Gvertical and GHorizontal) along x and y direction, is obtained by kernels that detect horizontal and vertical changes in the image. The sobel filter kernels are

$$Cvertical = \{-1\ -2\ -1; 0\ 0\ 0; 1\ 2\ 1\} \qquad (1)$$
$$Chorizontal = \{-1\ 0\ 1; -2\ 0\ 2; -1\ 0\ 1\}$$

The absolute value of the gradient images along the vertical and horizontal direction is obtained to form an absolute gradient image using the equation

$$G_{abs} = G_{Vertical} + G_{Horizontal} \qquad (2)$$

where Gvertical is the convolution of image with Cvertical and Ghorizontal is the convolution of image with Chorizontal. The absolute gradient image is used to find edges using Canny [8]. The edge image is scanned for pixel (P) having true value and the center is determined with the help of the following equations

$$xc = x - r * \cos(\theta) \qquad (3)$$
$$yc = y - r * \sin(\theta)$$

where x, y are the coordinates at pixel P and r is the possible range of radius values,   θ ranges from [0:π]
For a particular value of r, the values of xc and yc are obtained and stored in an accumlator and the accumulator counter is incremented every time the values of xc and yc satisfy image dimension criteria. The maximum value of accumulator counter gives the centre of the pupil along with the radius as shown in Figure 2.

Figure 1 Steps involved in detection of inner pupil boundary

OUTER IRIS LOCALIZATION

External noise is removed by blurring the intensity image. But too much blurring may dilate the boundaries of the edge or may make it difficult to detect the outer iris boundary, separating the eyeball and sclera. Thus a special smoothing filter such as the median filter [9] is used on the original intensity

image. This type of filtering eliminates sparse noise while preserving image boundaries. After filtering, the contrast of image is enhanced to have sharp variation at image boundaries using histogram equalization as shown in Figure 3(a). This contrast enhanced image is used for finding the outer iris boundary by drawing concentric circles, as shown in Figure 3(b), of different radii from the pupil center and the intensities lying over the perimeter of the circle are summed up. Among the candidate iris circles, the circle having a maximum change in intensity with respect to the previous drawn circle is the iris outer boundary. Figure 3(c) shows an example of localized iris image.
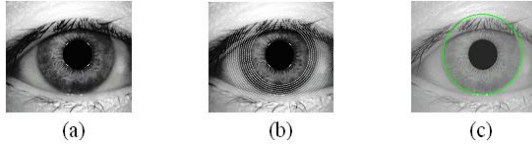

| (a) | (b) | (c) |

Figure 2 (a) Contrast enhanced image
(b) Concentric circles of different radii
(c) Localized Iris image

5. IRIS NORMALIZATION

Localizing iris from an image delineates the annular portion from the rest of the image. The concept of rubber sheet modal suggested by Daugman [2] takes into consideration the possibility of pupil dilation and appearing of different size in different images. For this purpose, the coordinate system is changed by unwrapping the iris and mapping all the points within the boundary of the iris into their polar equivalent as shown in Figure 4. The mapped image has 80 × 360 pixels. It means that the step size is same at every angle. Therefore, if the pupil dilates the same points are picked up and mapped again which makes the mapping process stretch invariant [10]. Thus the following set of equations are used to transform the annular region of iris into polar equivalent

$$I(x(\rho,\theta), y(\rho,\theta)) \rightarrow I(\rho,\theta) \qquad (4)$$

with

$$x_p(\rho,\theta) = x_{\rho 0}(\theta) + r_p * \cos(\theta)$$
$$y_p(\rho,\theta) = y_{\rho 0}(\theta) + r_p * \sin(\theta)$$
$$x_i(\rho,\theta) = x_{i0}(\theta) + r_i * \cos(\theta)$$
$$y_i(\rho,\theta) = x_{i0}(\theta) + r_i * \sin(\theta)$$

where rp and ri are respectively the radius of pupil and the iris, while (xp(θ), yp(θ)) and (xi(θ), yi(θ)) are the coordinates of the pupillary and limbic boundaries in the direction θ. The value of θ belongs to [0;2π], ρ belongs to [0;1].
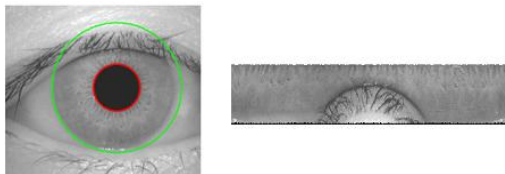

Figure 3 Iris normalization

6. FEATURE EXTRACTION

Corners in the normalized iris image can be used to extract features for distinguishing two iris images. The steps involved in corner detection algorithm are as follows
S1: The normalized iris image is used to detect corners using covariance matrix
S2: The detected corners between the database and query image are used to find cross correlation coefficient
S3: If the number of correlation coefficients between the detected corners of the two images is greater than a threshold value then the candidate is accepted by the system

where Aavg is the average of the area around point Ii and σ(A) is its standard deviation. Two corners are said to be co-related if cross correlation coefficient is greater than a given threshold value.

Iris verification using corners
Let A and B be the two iris images which are to be verified. Let P and Q be set of corners points detected in A and B. For each point p in P, let m points (q1……qm) in Q are less than d Euclidean distance from p. Let C1…….Cm be cross correlation coefficient between p and (q1……qm). If maximum of C1…….Cm is greater than a threshold then p is said to be matched between A and B.

Let I1 and I2 be the iris images of same person and I3 is another iris image to be verified. Let M1 be number of points matched between I1 and I2 and M2 be number of corner points matched between I1 and I3.
The images I1 and I3 is said to belong to same person if the hamming distance between M1 and M2 is less than the threshold value.

$$\frac{M_1 - M_2}{M_2} < \psi \qquad (5)$$

where Ψ is a threshold determined experimentally.

7. EXPERIMENTAL RESULTS

The work is carried on iris image CASIA database. Iris localization using Hough transform performs better as compared to other localization techniques in case of occlusion due to eyelids and eyelashes.
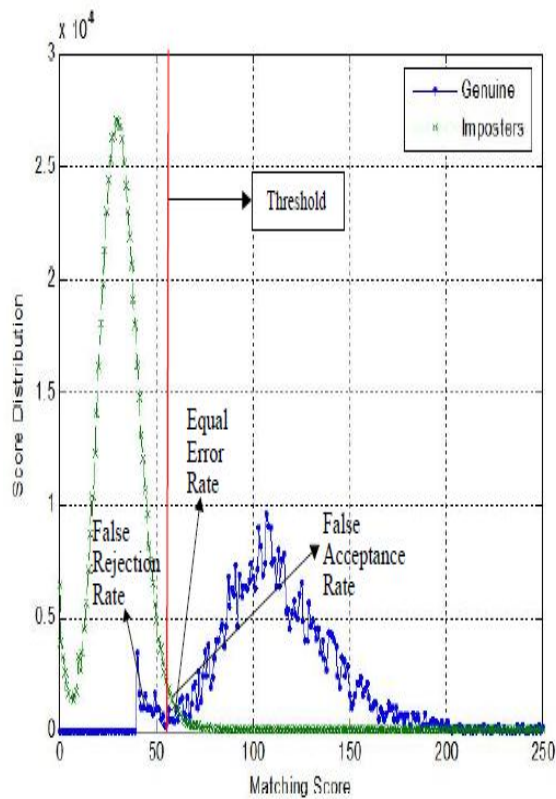
Figure5: Genuine matching score distribution

A public version of the *CASIA Iris Database* is available from sinobiometrics was of great help.

REFERENCES

[1]. L. Flom and A. Safir: Iris Recognition System. U.S. Patent No.4641394 (1987)

[2]. J. G. Daugman: High confidence visual recognition of persons by a test of statistical independence. IEEE Transactions on Pattern Analysis and Machine Intelligence Vol. 15 (1993) 1148–1161

[3]. W.W. Boles, B. Boashah: A Human Identification Technique Using Images of the Iris and Wavelet Transform. IEEE Transaction on Signal Processing Vol. 46 (1998) 1185-1188

[4]. R. Wildes, J. Asmuth, G. Green, S. Hsu, R. Kolczynski, J. Matey, S. McBride: A Machine-vision System for Iris Recognition. Machine Vision and Applications Vol. 9 (1996) 1-8

[5] Leila Fallah Araghi, Hamed Shahhosseini, Farbod Setoudeh.Iris Recognition using neural network.proceedings of the International Multiconference of engineers and computer scientist,2010 vol I, IMECS 2010.

[6]. T. Chuan Chen, K. Liang Chung: An Efficient Randomized Algorithm for Detecting Circles.Computer Vision &Image Understanding Vol. 83 (2001) 172-191

[7]. E. R. Davies: Machine Vision. 3rd Edition: Elsevier (2005)

[8]. J. Canny: A Computational Approach to Edge Detection. IEEE Transaction on Pattern Analysis and Machine Intelligence Vol. 8 (1986) 679-714

[9]. R. C. Gonzalez, R. E. Woods: Digital Image Processing. 2nd Edition, Pearson Education, India (2002)

[10]. Y. Zhu, T. Tan, Y. Wang: Biometric Personal Identification Based on Iris Patterns. Proced dings of ICPR, International Conference on Pattern Recognition Vol. II (2000) 805-808

[11] C. R. Prashanth1, Shashi kumar D.R.2, K. B. Raja, K.R.Venugopal, L. M. Patnaik High security: Human recognition system using Iris Images. International Journal of Recent Trends in Engineering, Vol. 1, No. 1, May 2009

[12] Lionel MARTIN: Person identification technique using human iris recognition Advanced system technologies Microelectron- ZI rousset-13106 rousset Cedex, France 2010.

.