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Human Recognition by Biometric Methods

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Report of Iris Recognition

Introduction:

Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on video images of one or both of the irises of an individual's eyes, whose complex patterns are unique, stable, and can be seen from some distance. This project bases on Daugman's algorithm, and consists of several main methods in order to classify different iris from a large given data base.

First the system has to localize the inner and outer boundaries of the iris (pupil and limbus) in an image of an eye. Further subroutines detect and exclude eyelids, eyelashes, and specular reflections that often occlude parts of the iris. The set of pixels containing only the iris, normalized by a rubber-sheet model to compensate for pupil dilation or constriction, is then analyzed to extract a bit pattern encoding the information needed to compare two iris images.

Discription of Daugman's algorithm:

Daugman's operator: The task is to find the centre coordinates and the radius of the iris and the pupil and Daugman's equation is employed for this task. The centre point of Daugman's theory of border recognition is the integrodifferential equation as follows.

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

I(x, y) is the intensity of the pixel at coordinates (x, y) in the image of an iris.

r denotes the radius of various circular regions with the center coordinates at (x0, y0).

σ is the standard deviation of the Gaussian distribution.

$G_\sigma(r)$ denotes a Gaussian filter of scale sigma (σ).

(x_0, y_0) is the assumed centre coordinates of the iris.

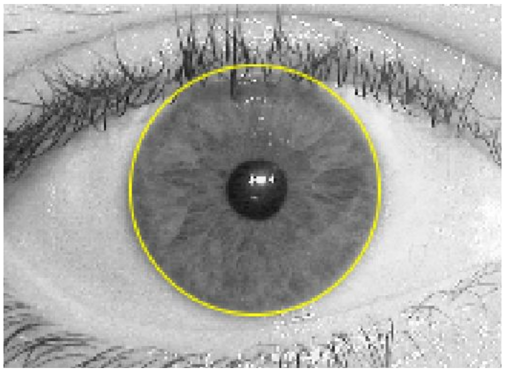

Figure 2.1 Result of Daugman method.

Hough transform:

$$(x - x_i)^2 + (y - y_i)^2 = r_i^2$$

The Hough transform is a feature extraction technique used in image analysis, computer vision, and digital image processing. where (xi, yi) are central coordinates, and r is the radius. Generally, and eye would be modeled by two circles, pupil and limbus (iris region), and two parabolas, upper and lower eyelids.

Starts to detect the eyelids form the horizontal direction, then detects the pupil and iris boundary by the vertical direction.

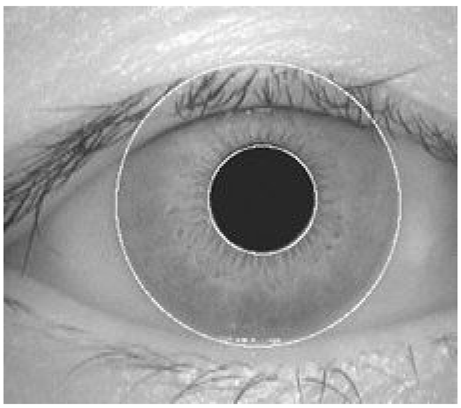

Figure 2.2

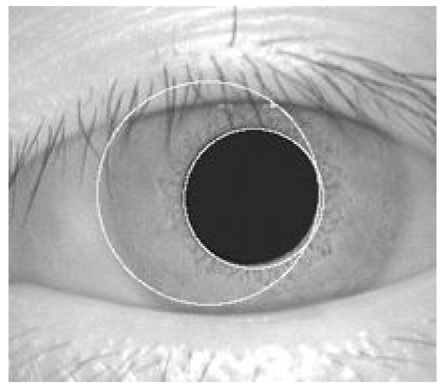

Figure 2.3

Normalization: After we have the circle of the iris, we need to transfer the circle to triangle. It is called normalization.

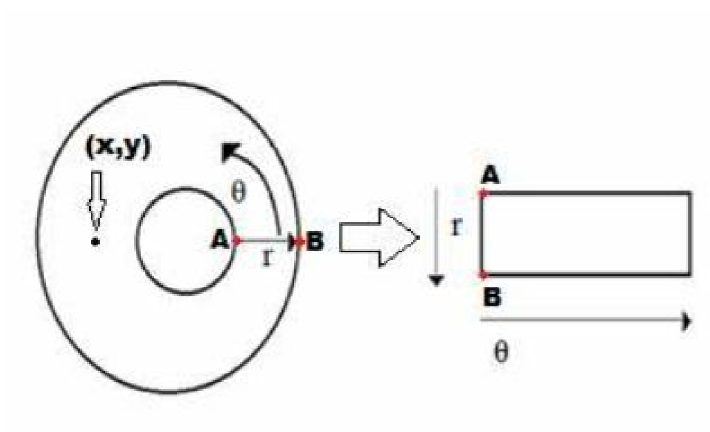

Figure 2.4 Principle of Rubber Sheet Normalization

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

The distance [0,1] is: r.

The angle [0, 2π] is ø.

The remapping of the iris region from (x, y) Cartesian coordinates to the normalized non-concentric polar representation is modeled as

$I(x(r,\pi \sim y(r,\pi)) \sim I(r,\pi)$

With

$x(r, \pi) = (1-r)x_p(\pi) + rx_1 \backslash (\pi)$

$y(r, \pi) = (1-r)y_p(\pi) + ry_1 \backslash (\pi)$

The iris region image is: I(x, y).

The original Cartesian coordinates are: (x, y).

The normalized polar coordinates are: (r, π).

The coordinates of the pupil and iris boundaries along the Bio-direction are: x_p, y_p and x_1, y_1. The rubber sheet model is useful for accounting pupil dilation and size inconsistencies. This model however does not compensate for rotational inconsistencies.

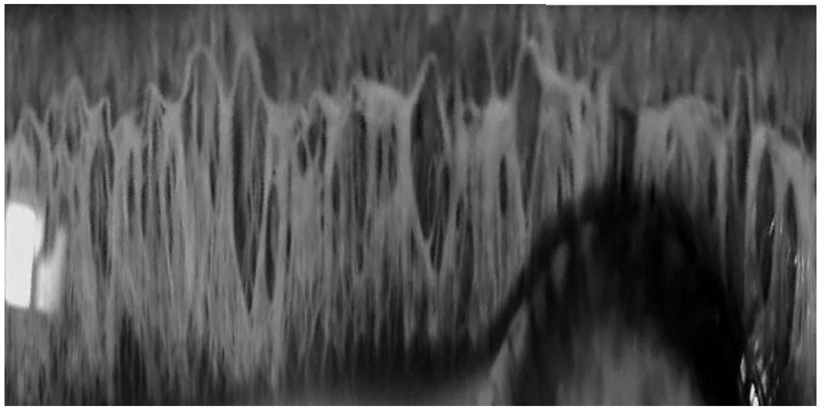

Figure 2.5 Normalization

Figure 2.6 Normalization vertical version.

Matching:

$$HD = \frac{|\,(codeQ \otimes codeR) \cap maskQ \cap maskR\,|}{|\,maskQ \cap maskR\,|}$$

where Q and R are subjects to compare, which contains 20x480=9600 template bits and 20x480=9600 mask bits, respectively, in order to calculate by using XOR and AND boolean operators.

Conclusion:

Due to the variety quailties of images, the acurrancy of Daugman's Algorithm will change. Generally, I get a pretty good result. By means of iris location method. the position of pupil can be further utilized to normalize it.