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Wavelet Demodulation based Iris Pattern Recognition

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Abstract — Security plays a prominent role now days in preventing the unauthenticated users to access the confidential data. To overwhelm the problems of existing technologies related with security issues a new concept i.e. Iris technology was proposed. So iris technology has resolved all the problems that are allied with the imperfections in the existing technologies used for authentication. In this paper we propose a new idea regarding the iris recognition based on wavelet demodulation technique .The iris that is externally visible is encoded into a sequence of 2D wavelet coefficients that produce iris code. The code that is obtained and the original code (actually in the database) are compared using exclusive operations.

Keywords- authentication; iris recognition; wavelet demodulation;wavelet coefficients .

I. INTRODUCTION

Historically, identity or authentication conventions were based on things one possessed (a key, a passport, or identity credential), or something one knew (a password, the answer to a question, or a PIN.) This possession or knowledge was generally all that was required to confirm identity or confer privileges. However, these conventions could be compromised - as possession of a token or the requisite knowledge by the wrong individual could, and still does, lead to security breaches.

To bind identity more closely to an individual and appropriate authorization, a new identity convention is becoming more Prevalent. Based not on what a person has or knows, but instead on what physical characteristics or personal behaviour traits they exhibit, these are known as biometrics measurements of behavioural or physical attributes - how an individual smells, walks, signs their name, or even types on a keyboard, their voice, fingers, facial structure, vein patterns or patterns in the iris.

Of all the biometric technologies used for human authentication today, it is generally conceded that iris recognition is the most accurate. The versatility of iris technology lends itself to virtually any application where identity authentication is required to enhance security, ensure service, eliminate fraud or maximize convenience.

Iris recognition is the best of breed authentication process available today. While many mistake it for retinal scanning, iris recognition simply involves taking a picture of the iris; this picture is used solely for authentication. The IrisAccess employs iris recognition technology to provide accurate identity authentication without PIN numbers, passwords or cards. Although the terminology "iris-scanning" is often used when referring to iris recognition technology, there is no scanning involved at all. Iris technology is based on pattern recognition

Now let's see the overall view working of the iris recognition system:

- With a device activated by proximity sensor, a subject positioned 3" to 14" from the Enrolment Optional Unit is guided by a mirrored, audio-assisted interactive interface to allow an auto-focus camera to take a digital video of the iris.
- Individual images from the live video are captured using a frame grabber. The innovative algorithm of the iris recognition process analyses the patterns in the iris that are visible between the pupil and sclera (white of the eye). This value is stored in a database and communicated to Identification Control Units associated with portals where the subject has access privileges.

In this paper a simple iris localization technique is described. It involves 4 sections in which section 1 describes the localization of image. Section 2 describes the transformation of the iris image obtained in step1. Section 3 describes the setting the bits for code by wavelet decomposition technique and section 4 describes the comparison of the iris codes.

II. IRIS RECOGNITION TECHNIQUE

Here the image that is scanned can be decomposed into 3 steps in which each step is discussed in detail.

A. Determination of boundaries of iris:

The image that is scanned is localized in a sequence of steps:

This process converts a gray image to binary image and efficiently segments the pupil from the rest of the image as shown in Fig.1. b. However, **morphological processing** is still necessary to remove pixels that located outside the pupil region. Figure 1.c shows the clear pupil region obtained from Fig. 1b after noise removing by using **dilate operator**. The approximate pupil center ---P (x_p, y_p) can be easily determined as the center of mass for the segmented pupil region, where the center of mass for an object refers to the balance point where there is equal mass in all directions. The pupil center detection process is shown in Fig. 1-c.

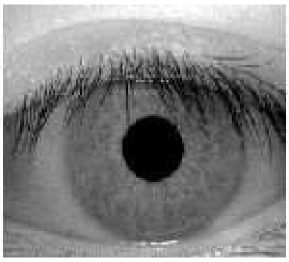

Figure 1.a

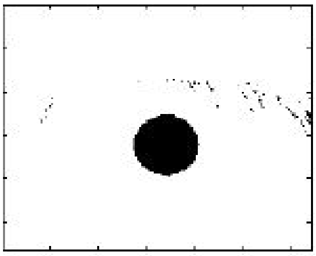

Figure 1.b

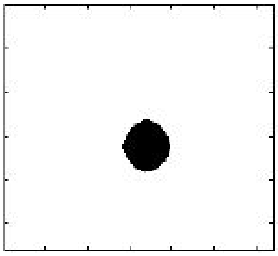

Figure 1.c

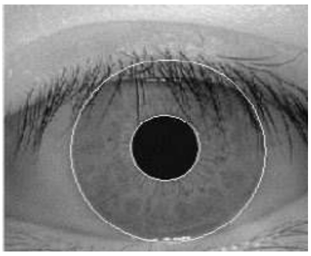

Figure 1.d

B. *Maintaining the Integrity of the Specifications*

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After the pupil center is found, Daugman’s integro differential operator is applied for locating the iris inner boundary. The integro differential operator is defined as:

$$\max_{(r,x0,y0)} \left| G_\sigma * \frac{\partial}{\partial r} \oint_{r,x0,y0} \left(\frac{I(x,y)}{2\pi r} \right) ds \right| \quad (2)$$

Where, I (x, y) is the eye image. The operator searches iteratively over the image domain (x, y) the maximum derivative, with respect to increasing radius r, of the normalized contour integral along a circular arc ds of radius r and center coordinates (x_0,y_0). The symbol * denotes convolution and $G_\sigma(r)$ is a smoothing function such as a Gaussian of scale s. Thus, Eq. 2 is used to determine the pupil boundary of the iris.

Finally, the precise iris center I (x_i, y_i) and radius R_i are obtained by fitting a circle to the outer boundary’s points detected in the previous step. As a method for curve fitting, the least square method which minimizes the summed square of errors is applied in present study. Figure 1-d shows the localized iris outer boundary.

C. *Transformation using polar coordinates:*

The localized iris part from the image should be transformed into polar coordinates system Locating iris in the image delineates the circular iris zone of analysis by its own inner and outer boundaries. The Cartesian to polar reference transform suggested by Daughman authorizes equivalent rectangular representation of the zone of interest as shown figure 2. In this way we compensate the stretching of the iris texture as the pupil changes in size, and we unfold the frequency information contained in the circular texture in order to facilitate next features extraction. Moreover this new representation of the iris breaks the no eccentricity of the iris and the pupil. $\theta(\theta \in [\theta, 2\pi])$ Parameter and dimensionless p(p $\in$[0;1]) parameter describe the polar coordinate system. Thus the following equations implement:

$I(x(p, \theta), (p,\theta) \rightarrow I(p,\theta)$

Where

$X(p, \theta) = (1 - p) * x(\theta) + p * xi(\theta)$

$Y(p, \theta) = (1 - p) * yp(\theta) + p * yi(\theta)$

$Xp(\theta) = Xp0(\theta) + rp * \cos(\theta)$

$Yp(\theta) = Yp0(\theta) + rp * \sin(\theta)$

$Xi(\theta) = Xto(\theta) + ri * \cos(\theta)$

$Yi(\theta) = Yto(\theta) + ri * \sin(\theta)$

Where r_p and r_i are respectively the radius of the pupil and the iris, while $(x_p(\theta), yp(\theta)$ and $((xp(\theta), yi(\theta))$ are the coordinates of the pupillary and limbic Boundaries in the direction θ. Figure (2) depicted how iris image is converted to polar coordinates.

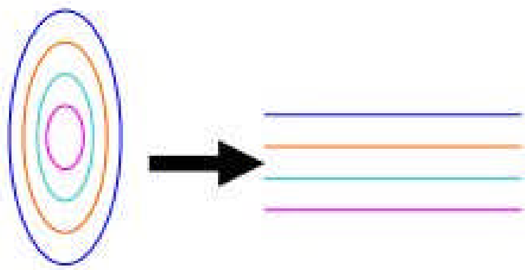

Figure 2: Polar Coordinates

D. *demodulation of iris code using wavelets:*

An "Iris Code" is constructed by *demodulation* of the iris pattern. This process uses complex-valued 2D Gabor wavelets to extract the structure of the iris as a sequence of phasors, whose phase angles are quantized to set the bits in the Iris Code. This process is performed in a doubly-dimensionless polar coordinate system that is invariant to the size of the iris and also invariant to the dilation diameter of the pupil within the iris. The demodulating wavelets are parameterized with four degrees-of-freedom: size, orientation, and two positional coordinates. They span several octaves in size, in order to extract iris structure at many different scales of analysis.

Because the information extracted from the iris is inherently described in terms of phase, it is insensitive to contrast, camera gain, and illumination level. Any given Iris Code is statistically guaranteed to *pass* a test of independence against any Iris Code computed from a different eye; but it will uniquely *fail* this same test against the eye from which it was computed. Thus the key to iris recognition is the *failure of a test of statistical independence*. The equations and the wavelet phasors diagram below summarize the pattern encoding process. Using a Boolean XOR similarity metric on the phasors bit strings generates similarity scores among different Iris Codes that are binomially-distributed and that therefore have tails that attenuate extremely rapidly.

H_{Re}=1 if

$$\int_{\rho}\int_{\varphi} e^{-i\omega(\theta-\varphi)} e^{-\frac{(r-\rho)^2}{\alpha^2}} e^{-\frac{(\theta-\varphi)^2}{\beta^2}} I(\rho,\varphi)\rho d\rho d\varphi \geq 0$$

H_{Re}=0 if

$$\int_{\rho}\int_{\varphi} e^{-i\omega(\theta-\varphi)} e^{-\frac{(r-\rho)^2}{\alpha^2}} e^{-\frac{(\theta-\varphi)^2}{\beta^2}} I(\rho,\varphi)\rho d\rho d\varphi < 0$$

H_{im}=0 if

$$\int_{\rho}\int_{\varphi} e^{-i\omega(\theta-\varphi)} e^{-\frac{(r-\rho)^2}{\alpha^2}} e^{-\frac{(\theta-\varphi)^2}{\beta^2}} I(\rho,\varphi)\rho d\rho d\varphi \geq 0$$

H_{rm}=0 if

$$\int_{\rho}\int_{\varphi} e^{-i\omega(\theta-\varphi)} e^{-\frac{(r-\rho)^2}{\alpha^2}} e^{-\frac{(\theta-\varphi)^2}{\beta^2}} I(\rho,\varphi)\rho d\rho d\varphi < 0$$

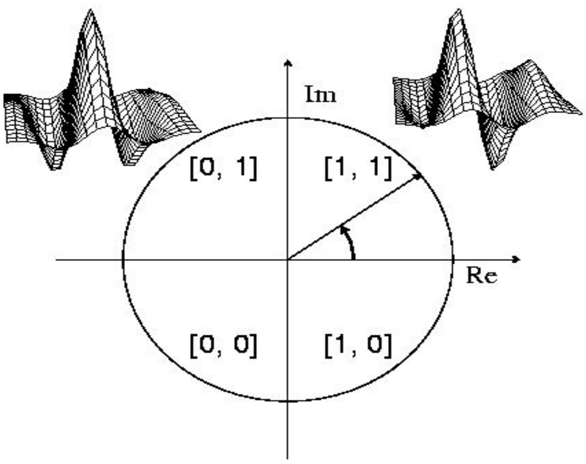

Figure 3: Phase Quadrant Iris Demodulation Code

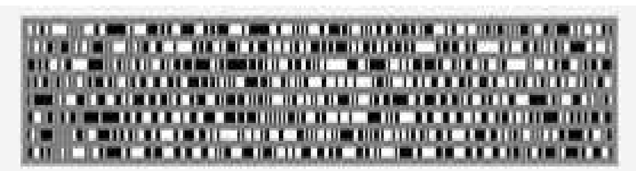

Figure 4: Pattern of Iris Code After Demodulation

E. Match comparison:

The comparison is virtually guaranteed to be passed whenever the phase codes for two different eyes are compared, but to be uniquely failed when any eye's phase code is compared with another version of itself. The test of statistical independence is implemented by the simple Boolean Exclusive-OR operator (XOR) applied to the phase vectors that encode any two iris patterns, masked (AND) by both of their corresponding mask bit vectors. The XOR operator $\otimes$ detects disagreement between any corresponding pair of bits, while the AND operator $\cap$ ensures that the compared bits are both deemed to have been uncorrupted by eyelashes, eyelids, specular reflections, or other noise. The norms (|| ||) of the resultant bit vector and of the AND'ed mask vectors are then measured in order to compute a fractional Hamming Distance (HD) as the measure of the dissimilarity between any two irises, whose two phase code bit vectors are denoted {codeA, codeB} and whose mask bit vectors are denoted {maskA, maskB}.

$$HD=\frac{||(codeA \otimes codeB) \cap maskA \cap maskB||}{||maskA \cap maskB||}$$

III. CONCLUSION

In this paper, wavelet demodulation is used to extract the bits of the human iris that is scanned. The bits obtained from the demodulation technique are then converted into the binary codes to be used for the calculation of the hamming distance for matching purpose. Wavelet demodulation technique is simple when compared with other techniques because of its computational simplicity [6-8].

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