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A Novel Identification System Using Fusion of Score of Iris as a Biometrics

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Abstract - *Biometric person authentication using iris is well suited to be applied to any access control system requiring a high level of security. This paper proposes iris recognition system that implements a fusion of two iris images at decision level. For the extraction of the deterministic patterns in a person's iris the Gabor filtering and wavelet transform is used. A CASIA iris database of iris images has been used in the implementation of the iris recognition system. The results show that proposed method is quite effective.*

Keywords*: Iris recognition, Iris Localization, decision level fusion*

I. Introduction

Biometric verification is any means by which a person can be uniquely identified by evaluating one or more distinguishing biological traits. Unique identifiers include fingerprints, hand geometry, earlobe geometry, retina and iris patterns, voice waves, DNA, and signatures. Among many biometrics techniques, iris recognition is one of the most promising approaches due to its high reliability for personal identification [1–8]. Iris recognition is a method of biometric authentication that uses pattern recognition techniques based on high-resolution images of the irides of an individual's eyes. Most of the commercial iris recognition systems implement a famous algorithm for iris recognition using iris codes. One of the difficult problems in feature-based iris recognition is that the matching performance is significantly influenced by many parameters in feature extraction process (e.g., spatial position, Orientation, center frequencies and size parameters for 2D Gabor filter kernel), which may vary depending on environmental factors of iris image acquisition. The iris is unique to an individual and is stable with age [6]. This is a key advantage of iris recognition as its stability, or template longevity as, barring trauma, a single enrollment can last a lifetime. Fusion of more than one biometrics makes the system more robust and accurate [9-10]. The fusion of different biometrics can be done at various levels, namely, sensor level, feature level [11], matching score level [12] and decision level. Fusion of multiple biometrics i.e. Multiple snaps of Iris makes possible to achieve highly robust identification in a unified fashion with a simple matching algorithm. In this paper a biometric system based on fusion of decision level for iris features is proposed for robust personal identification. It consists of a technique of localization, alignment, feature extraction, matching the features of irises and finally the fusion is made for decision regarding the degree of match.

II. Proposed Iris recognition system

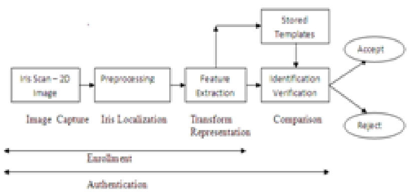

Fig.1. Proposed Iris recognition system

II.1. Image acquisition

The system captures eye images with the iris diameter typically between 100 and 200 pixels from a distance of 15–46 cm using a 330-mm lens.

II.2. 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:

1. Pupil detection
2. Outer iris localization

III.3. Feature extraction

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination.

Other sources of inconsistency include, varying imaging distance, rotation of the camera, head tilt, and rotation of the eye within the eye. The normalization process will produce iris regions, which have the same constant dimensions. The homogenous rubber sheet model devised by Daugman [8] remaps each point within the iris region to a pair of polar coordinates (r, θ) where r is on the interval [0, 1] and θ is angle [0,2π].

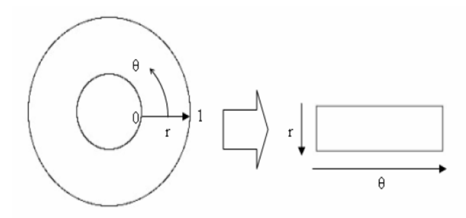

Fig.2. Daugman's Rubber Sheet Model.

The remapping of the iris region from (x, y) Cartesian coordinates to the normalized non-concentric polar representation is modeled as Eq. 1.

$$I(x(r, \theta)\ y(r, \theta)) = I(r, \theta) \qquad (1)$$

with

$$x(r, \theta) = (1 - r)\, xp(\theta) + r\, xi(\theta)$$
$$y(r, \theta) = (1 - r)\, yp(\theta) + r\, yi(\theta)$$

Where I(x, y) is the iris region image, (x, y) are the original Cartesian coordinates, (r, θ) are the corresponding normalized polar coordinates, and xp, yp and xi, yi are the coordinates of the pupil and iris boundaries along the θ direction.

The centre of the pupil was considered as the reference point, and radial vectors pass through the iris region, as shown in Fig. 3.

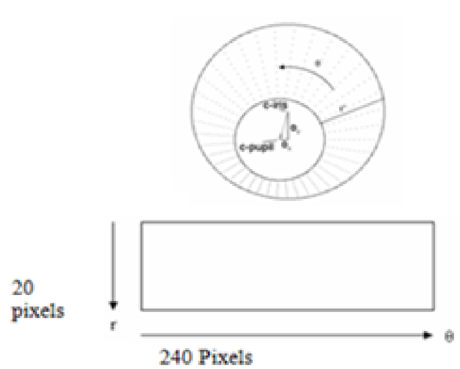

Fig.3. Normalization Process with radial resolution

The normalization process proved to be successful, a constant number of points are chosen along each radial line, here 20 pixel points are chosen as number of radial data points are

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taken, and 240 pixel points for angular data points are selected to create a 2D array, as shown in fig.4.
Normalization produces a 2D array with horizontal dimensions of angular resolution and vertical dimensions of radial resolution as shown in Fig.5. Another 2D array for marking reflections, eyelashes, and eyelids to prevent non-iris region data from corrupting the normalized representation, as shown in Fig.6 below.

Feature Encoding: After iris region is segmented, to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted to create a biometric template. Only the significant features of the iris must be encoded so that comparisons between templates can be made.

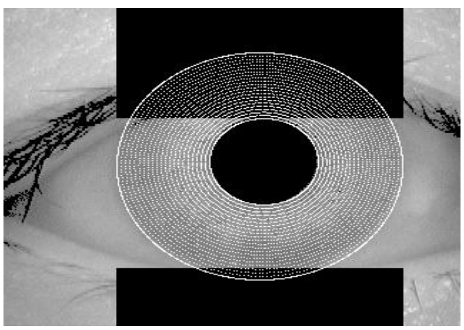


Fig.4. Radial and angular pixel from iris region

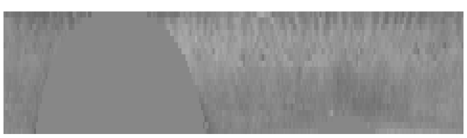


Fig.5. Normalized Iris (Polar array)

Fig.6. Mask for normalized iris (Polar Mask)

Gabor filters are able to provide optimum conjoint representation of a signal in space and spatial frequency. A Gabor filter is constructed by modulating a sine/cosine wave with a Gaussian. This is able to provide the optimum conjoint localization in both space and frequency, since a sine wave is perfectly localized in frequency, but not localized in space. Modulation of the sine with a Gaussian provides localization in space, though with loss of localization in frequency. Decomposition of a signal is accomplished using a quadrature pair of Gabor filters, with a real part specified by a cosine modulated by a Gaussian, and an imaginary part specified by a sine modulated by a Gaussian. The real and imaginary filters are also known as the even symmetric and odd symmetric components respectively.

III.4. Matching

In comparing the bit patterns X and Y, the Hamming distance, HD, is defined as the sum of disagreeing bits (sum of the exclusive-OR between X and Y) over N, the total number of bits in the bit pattern as given in Eq.

$$HD = \frac{1}{N}\sum_{j=1}^{N} X_j (XOR) Y_j$$

Used Algorithm:

1) Image Acquisition: Acquire the iris image by a Iris scanner. Acquire the two images one after another of same eye.
2) Perform the step number 3 to 6 on both images
3) Segmentation: Separate out the iris image from the acquired image using the following steps
   - Edge detection is to be performed on the image
   - Circles for Iris and Pupil Boundary are to be detected using Hough transform
   - Eyelid are to be detected are remove from the iris image.
4) Normalization: the region between the iris and pupil is to be normalized like the rubber sheet model.
5) From the normalized image Feature are to be extracted by using LOG Gabor transform and Encoded
6) Matching distance: Hamming distance is to be obtained between the test and Query image.
7) Fusion: Two hamming distances D1 and D2 are obtained. If D1 or D2 is less than Threshold the image is recognized. Otherwise it is rejected.

III. Fusion of Decision Level

Two iris images are used to find the two Hamming distances of test images with Query. Two hamming distances are given by D1 and D2. If D1 or D2 is less than Threshold the image is recognized. Otherwise it is rejected. This makes the robust to accept the person under query.

IV. Result

The result obtained after experimentation are calculated. The percentage Accuracy Based on FAR (False Acceptance Ratio), FRR (False Reject Ratio) and RAR (Right Acceptance Ratio) of the implemented algorithm is given in Table I for single biometrics and Table II gives the result for Fusion of Iris at decision level as given below.

TABLE I

Threshold	RAR	FRR	FAR
0.3	68	32	0.0408
0.35	86.66	13.33	0.040
0.4	92.66	7.33	0.0816
0.435	94.66	5.33	2.64
0.45	97.33	2.66	11.93

Result in terms of RAR, FRR, FAR for Single Iris image.

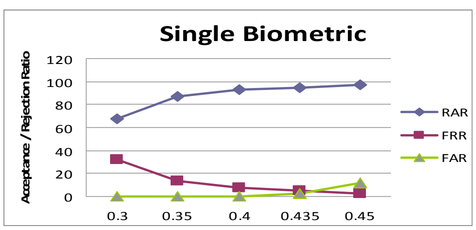
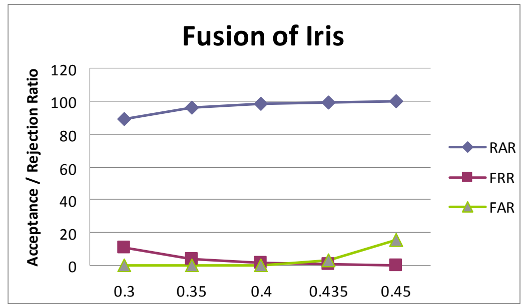
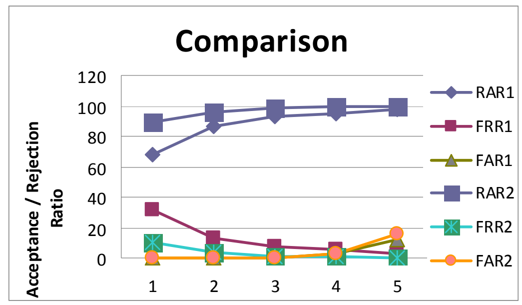


TABLE II

Threshold	RAR	FRR	FAR
0.3	89.33	10.66	0
0.35	96	4	0
0.4	98.66	1.33	0.04
0.435	99.33	0.66	2.87
0.45	100	0	15.41

Results in terms of RAR, FRR, FAR for Multiple Iris image.





V. Conclusion

The developed system of Biometrics using fusion at decision level for person identification is tested and the results are all described earlier, shows a good separation of intra-class and inter-class for different persons. If selected threshold is changed according to determined Hamming Distances such that if we select the maximum Hamming distance of that particular Person, and considering same as threshold for decision it can improve decision making accuracy. The computational complexity of the proposed system is more as we use the non orthogonal transform (Gabor Transform) for extracting the features. As mentioned in result the recognition rate gets improved due to the fusion of multiple iris images. The results obtained are more robust in multimodal system as compared to single biometrics system.

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