International Journal of Engineering Research and General Science Volume 2, Issue 4, June-July, 2014
ISSN 2091-2730

Biometric Template Feature Extraction and Matching Using ISEF Edge Detection and Contouring Based Algorithm

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Abstract— In present world, biometric base authentication system is used by many agencies for security purpose. Use of important characteristics of biometric based authentication system become so popular because every human presents unique biometric characteristics and biometric recognition done automatically. Biometric authentication system is divided into four steps like biometric template acquisition using sensor, feature extraction, template matching and decision about authentication. In this paper, we are described new approach for biometric template feature extraction and template matching using combination of ISEF edge detection and contour based biometric recognition algorithm. We have explored infinite symmetric exponential filter properties of ISEF algorithm on iris biometric template which is applicable on particular edges points of template. This proposed approach has been applicable on fingerprint, iris, and face biometric template of human. This proposed approach has applied on iris biometric template because of less algorithm is available in literature for iris biometric recognition because of popularity of iris biometric template used for human identification.

Keywords— Biometric Recognition, Contouring, Edge Detection, Feature Extraction, ISEF, Iris Pattern, Template Matching.

INTRODUCTION

During so many years in biometric image recognition processing, human identification is done automatically by various templates matching algorithm which is based on human characteristics like fingerprint, face, iris, Palm print and teeth. Biometric recognition is challenging topics in pattern recognition area. Biometric recognition is used for enrollment, verification and authentication of biometric template in biometric system [1]. In an enrollment process, the system enrolled human's characteristics which may be iris or fingerprint into system database. In a verification process, the system is verified query human's characteristics with enrolled human's own biometric characteristics. In authentication process, the system authenticates a human's characteristics by comparing the entire enrolled biometric characteristics with human own biometric templates stored in system database [2, 3].

In last decade many algorithms are proposed and describe for iris recognition are reviewed here. Iris recognition algorithm is analyzing the random pattern of human's iris [4]. First iris recognition and systems introduced by John Daugman in 2004 [5]. Author in [5] described iris algorithm based on 2D Gabor wavelet which identify outer boundaries of the iris and the pupil. The data of this region is converting into binary values pattern and which is used for human identification. When query iris image presented by a human then statistical comparison taken place between query template and enrolled template for verification or authentication.

Author in [6] described iris algorithm using phase based image matching. In this algorithm phase components of 2D Discrete Fourier Transforms (DFT) of iris image is used for template matching. Author in [7] developed an open source iris recognition algorithm based on Daugman's method by using MATLAB. This iris recognition algorithm is dividing into three steps like automatic segmentation, normalization and feature encoding and matching. Authors in [8] described iris recognition algorithm based on combination of PCA and ICA. Authors shown that when PCA and ICA methods are used for encoding iris image then achieved good performance of iris recognition algorithm.

In authors in [9] proposed new iris recognition algorithm using edge detection and zero crossing of wavelet transform [10]. They are calculated zero crossing value of various wavelet resolution level of concentric circles on the iris. These values are used as model features for compare with enrolled features values. This system can use under noisy condition and various illumination. In authors in [10] shows similar approach of authors proposed in [11] which is based on zero-crossing discrete dyadic wavelet transform representation and this approach approved accuracy of iris recognition. Authors in [12] proposed iris feature extraction algorithm based on Multi-resolution Independent Component Identification (M-ICA). This extracted feature is compared with enrolled data using conventional matching algorithms. Authors in [13] proposed Thresholding based iris recognition algorithm for detection of pupil and the surroundings of iris image and convert into a rectangular format. This pattern is matched with enrolled data using self organizing map networks and accuracy of algorithm is 83%.

Authors in [14, 15] proposed iris recognition algorithm based on circular symmetry filters and this filters used to capture local texture information of iris image which is used for construction of a fixed length feature vector. The results of proposed algorithm were

0.01% for False Acceptance and 2.17 % for False Rejection. Authors in [16] proposed iris feature extraction algorithm using fractal dimension where iris is divided into small blocks and based on this block local fractal features is computed as iris pattern. The results of proposed algorithm were 91% acceptance for enrolled user and 100% rejection for imposter user. Authors in [17] proposed recognition algorithm for iris used Gabor filters and wavelet transform. The performance of method is does not change to translation, rotation and tolerant to illumination. Authors in [18] proposed new iris algorithm for extraction of iris feature. In this method, localization of iris image is get using Hough transform and feature is get using instantaneous phase or emergent. The iris pattern is generated using Thresholding of frequency and real and imaginary parts of phase. Finally the matching is performed using Hamming distance.

Authors in [19] proposed iris feature extraction using Haar wavelet transform and fourth level wavelet applied on iris image to get 87 bit feature vector. The recognition rate obtained is around 98.4%. Authors in [20] proposed two iris rogation algorithms based on partly on the correlation analysis and partly on the median binary code of commensurable regions of digitized iris image. Similarly method of eye-iris structure using statistical and spectral analysis of color iris images is proposed by authors in [21]. Authors in [21] proposed iris feature extraction using Wiener spectra to characterized iris image. Authors in [22, 23] explained human iris structure and classified using coherent Fourier spectra of the optical transmission. Authors in [24] proposed iris recognition algorithm for biometric security with high performance and confidence. In this method, following steps are followed acquiring iris patterns, determine the local of iris boundaries, converting iris boundary to polar coordinate, extracting iris code based on texture analysis of wavelet and classification of the iris code. This proposed algorithm used wavelet transforms for feature analysis and depends on the knowledge of general structure of human iris. Authors in [25] are gives review and comparison of various extraction and recognition algorithms for human iris image.

In this paper we have described the ISEF based edge detection and contour based biometric recognition algorithm used for iris template feature extraction recognition and iris template matching in biometric system. The organization of the paper is as follows: section 2 briefly describes the ISEF algorithm; section 3 gives contour algorithm; section 4 gives proposed algorithm; section 5 gives experimental results and conclusion in section 6.

ISEF EDGE DETECTION ALGORITHM [26, 28, 32 AND 34]

The Shen – Castan is introduced novel edge detection algorithm based on infinite symmetric exponential filter (ISEF) [26, 29]. This algorithm is divide into following steps like recursion filtering in X direction, recursion filtering in Y direction, binary Laplacian image, non maximum suppression, gradient, hysteresis Thresholding, thinning [26, 28 32 and 34]. Shen and Castan agree with Canny about the general form of the edge detector a convolution with a smoothing kernel followed by a search for edge pixels [27, 29]. The steps of ISEF edge detection algorithm is applied on any biometric image are given in table 1 and get edges of biometric image. Figure 1 shows the result of applying the canny edge detector and Shen – Castan edge detector to the test biometric image.

(a) Canny Operated

(b) ISEF Operated

Figure 1. Edge Detector Performance on Test Iris Image

Table I
ISEF EDGE DETECTION ALGORITHM [26, 28, 32 AND 34]

Sr. No.	Steps
1	Recursive Filtering in X Direction
2	Recursive Filtering in Y Direction
3	Apply Binary Laplacian Technique
4	Apply Non Maxima Suppression

5	Find the Gradient
6	Apply Hysteresis Thresholding
7	Apply Thinning

CONTOUR ALGORITHM [30 AND 33]

The information of contour algorithm is taken from reference papers [30, 33] which give application contour on image and how contour label is applied on contour of image to get matrix values. The contour c function calculates the contour matrix for the other contour functions. It is low level function that is not called from the command line. Contour, contour3 and contourf return a two row matrix specifying all the contour lines [30, 33]. The format of the matrix is

C = [value1 xdata (1) xdata (2)...
Num v ydata (1) ydata (2)...]

The first row of the column that begins each definition of a contour line contains the value of the contour as specified by v and used by clabel. Beneath that value is the number of (x, y) vertices in the contour line. Remaining columns contain the data for the (x, y) pairs [30, 33].

PROPOSED BIOMETRIC RECOGNITION ALGORITHM

Based discussion on ISEF edge detection algorithm and contour algorithm, we formatting block diagram of proposed biometric recognition which is based on ISEF edge detection algorithm and contour algorithm is shown in figure 2. First step of algorithm is that acquire query biometric template from biometric sensor and then applied ISEF edge detection algorithm on biometric template and extract biometric features of query template. After getting features in term of edges applied contouring and contour label on this edges and get contour matrix which is used as feature values for comparison. This contour matrix value is compared with enrolled contour matrix value of human which is store at time of enrollment process. Score between these two contour matrix values take decision about human authentication. The proposed iris recognition outline is given table 2.

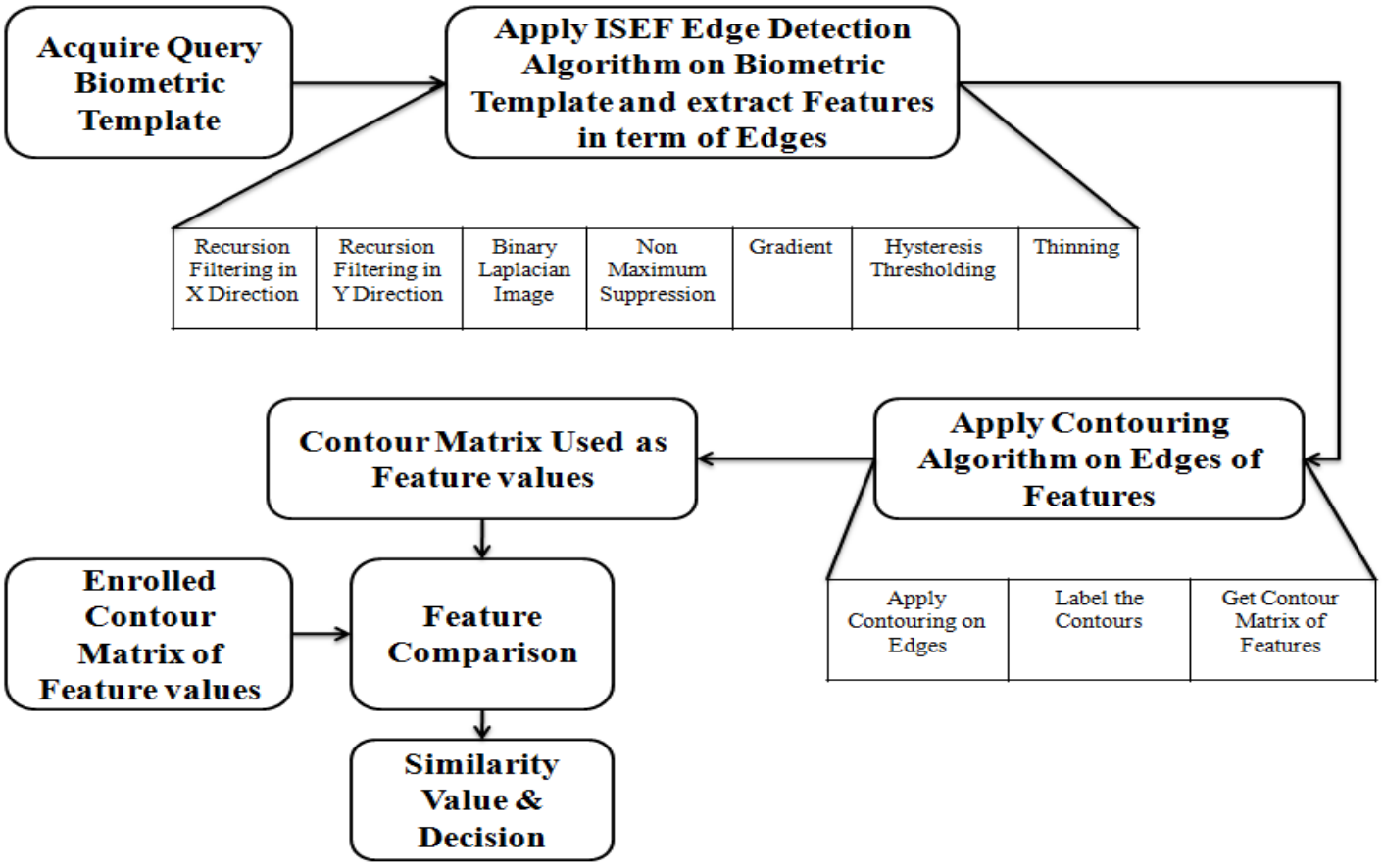


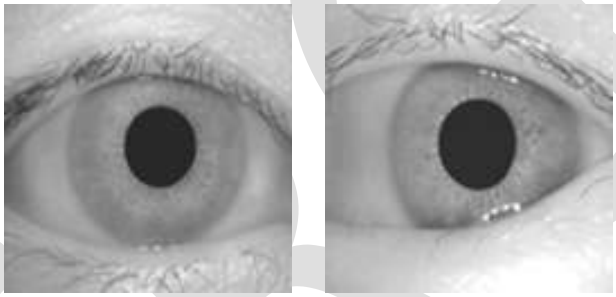
Figure 2. Block Diagram of Proposed Biometric Recognition Algorithm

Table II
PROPOSED BIOMETRIC RECOGNITION ALGORITHM

Steps No.	Action Taken
1	Acquire Biometric Template
2	Apply ISEF Edge Detection Algorithm on Biometric Template
3	Apply Image Contouring on Extracted Edges of Biometric Template
4	Label the Contours to get Contour Matrix Values of Biometric Template
5	Used the Contour Matrix Values as Feature of Biometric Template for Comparison
6	Match Extracted Digits of Contour Matrix of Feature of Biometric Template with Digits of Contour Matrix of Feature of Database Biometric Template
7	Decision on Biometric Recognition and Human Identification.

EXPERIMENTAL RESULTS

Performance of the proposed biometric template recognition algorithm is evaluated using a database containing iris template from CASIA iris database [31] which is shown in figure 2. The size of iris image is M × N = 128 ×128 pixels selected.

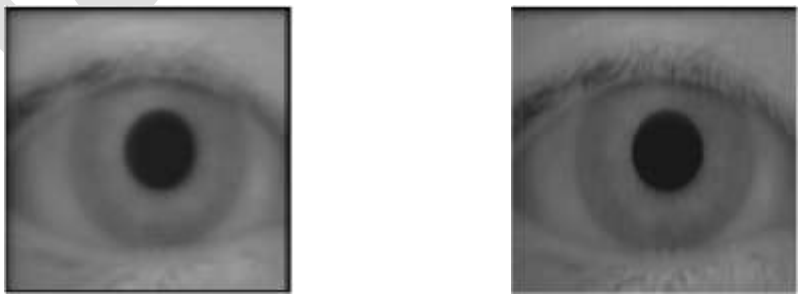


(a) (b)

Figure 3. Sample Test Iris Images form CASIA Database (a) I1 (b) I2

An automated iris recognition system consists of two main stages: feature extraction and feature matching. In this paper, the feature extracted is the iris contours and feature matching taken place between contour values of query template and enroll template of human. The edge can be detected by any of template based edge detector but Shen Castan Infinite Symmetric Exponential Filter based edge detector is an optimal edge detector like canny edge detector which gives optimal filtered image [26, 34]. First the whole iris image will be filtered by the recursive ISEF filter in X direction and in Y direction [26, 28 and 34].

As shown in result in fig. 4 (a) and (b) recursive filter is applied in X direction and then in Y direction on iris image. Fig 5 is binary Laplacian iris image which is derived by filtered image – original image. Fig 6 is getting after applying gradient on binary Laplacian image. Fig 7 is generated by applying code for Recursion filtering in X, direction Recursion filtering in Y direction, Binary Laplacian Image, Non maximum suppression, Gradient, Hysteresis Thresholding & Thinning on iris image. Finally we have found that by contour coded applied to ISEF edge detected iris image and original iris image which is shown in fig 8 and 9 respectively.



(a) Recursive Filter in X Direction (b) Recursive Filter in Y Direction

Figure 4. Recursive Filtering on Test Iris Image I1

Figure 5. Binary Laplacian Test Iris Image I1

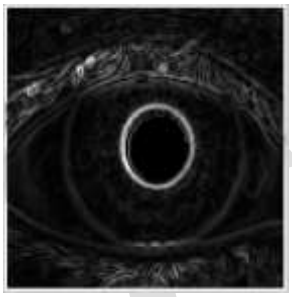


Figure 6. Gradient Test Iris Image I1

Figure 7. ISEF Operated Test Iris Image I1

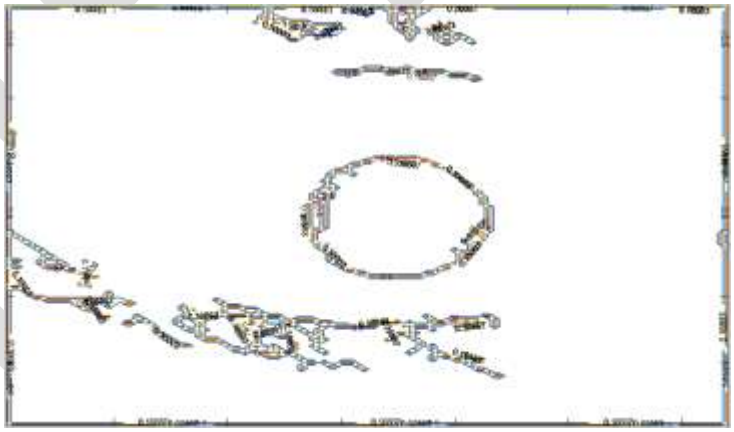


Figure 8. Contour on ISEF Operated Test Iris Image I1

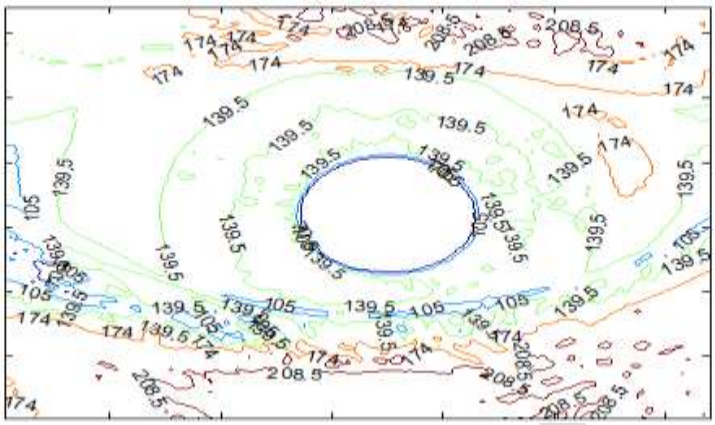


Figure 9. Contour on Original Test Iris Image I1

Finally we have found that by various contour codes applied to fig 8 and fig 9, we got more than 10000 columns. We have taken only 4001 to 4007 no of columns. The contour matrix values of original iris image and ISEF operated iris image in table 3 and 4 respectively.

Table III
CONTOUR MATRIX VALUES OF COLUMNS 4001 TO 4007 FOR ORIGINAL IRIS TEST IMAGE I1

111.1	111.1	111.0	110.0	109.0	108.0	107.9
6.00	5.00	4.88	4.88	4.88	4.50	4.00

Table IV
CONTOUR MATRIX VALUES OF COLUMNS 4001 TO 4007 FOR ISEF OPERATED IRIS TEST IMAGE I1

56.0	56.0	0.33	74.0	73.7	74.0	74.3
68.3	68.3	5.0	127.3	126.7	17.0	127.3

These columns are ready for iris template matching. Then find comparison between contour matrix values of query iris image and contour matrix values of enrolled iris image and if result of comparison is zero then human is identified other human cannot recognized . So when iris image of enrolled human is come for query at sensor then match almost all the columns are nearly equal, and Euclidean distance between digits of query contour matrix and digits of enrolled contour matrix is zero. Table 5 shows contour matrix values of iris Test image I2 which is given in figure 3 which different than contour matrix values of iris test image I1 which is indicate contour matrix values of different iris image is different and it used as recognition decision of iris image for human identification. For performance analysis of this proposed algorithm, we have taken 50 iris images from database and chose contouring size 5 with setting threshold value is less than 100 and considering image 50 as enrolled iris data in system database. The results show in table 6 that when image one is come as query then percentage of matching is 100 otherwise is less than 85.00 percentages.

Table V
CONTOUR MATRIX VALUES OF COLUMNS 4001 TO 4007 FOR ISEF OPERATED IRIS TEST IMAGE I2

50.0	51.0	52.0	53.0	54.0	55.0	56.0
101.7	101.7	101.7	101.7	101.7	101.7	101.7

Table VI
MATCHING PERCENTAGE OF PROPOSED RECOGNITION ALGORITHM FOR TEST IRIS IMAGE I1

Image Number	Matching Percentages
1	100
10	84.40
20	30.10
30	29.40
40	29.40
50	25.10

ACKNOWLEDGMENT

The authors are highly thankful to National Laboratory of Pattern Recognition (NLPR), Institute of Automation, Chinese Academy of Sciences (CASIA), China to provide iris image database.

CONCLUSION

In this paper we have proposed novel algorithm for iris recognition based on ISEF edge detection algorithm and contour based algorithm. Here we have applied proposed recognition algorithm on test iris image, we have got more than 10000 columns of contour data. Form these columns, we choose 4001 to 4010 columns of contour data used for matching of iris image and matching is same when query iris image is belong to enrolled human's iris image than matching of all the columns are nearly equal, otherwise different columns are there. This proposed algorithm has good performance for iris recognition under noisy environment because of application of recursive filtering before applying edge detection.

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