Development a New Algorithm for Iris Biometric Recognition

Raida Hentati, Manel Hentati, and Mohamed Abid

Abstract—**Biometric technologies are defined as the automated methods of identifying or authenticating the identity of a living person based on a physiological or behavioral characteristic. Among biometric technologies, iris recognition has received increasing attention due to its high reliability. Iris recognition is a biometric authentication technology that uses pattern recognition techniques based on iris characteristics. In this paper, we propose a new algorithm based on Iris biometric. The system acquires the biometric data in the data base CASIA version 1.0. The algorithm gives the accuracy of more than 92. %. Also the time required for iris identification is less than one second.**

Index Terms—**Recognition, biometric, iris, hough transforms, gabor wavelets.**

I. Introduction

Biometrics refers to the use of physiological or biological characteristics to measure the identity of an individual. These features are unique to each individual and remain unaltered during a person's lifetime. These features make biometrics a promising solution to find security. Automated biometrics recognition systems can be classified into two main categories: identification and verification. In the fisrt category, identification systems try to identify a person which belongs to a group that previously has been enrolled. On the second category, verification systems match a biometric sample with a single template, which belongs to a previously declared user. Both categories of systems have two main stepq: enrollment and verification; during enrollment the biometric of the subject is stored in a database, and during verification the biometric information of the subject is detected and compared [9].

The biometric techniques can be classified into three classes [3]: Biological (blood, odor, and saliva…), behavioral (signature, akeyboard typing, gait, voice…) and morphological (iris, Fingerprint Face, the hand geometry, retinal…) among the available biometric traits some of the traits outperform others. The reliability of several biometrics traits is measured with the help of experimental results.

Iris is commonly accepted as one of the most accurate biometric traits and has been successfully applied in such distinct domains as airport or refugee control.

It is the annular region of the eye bounded by the pupil and the sclera (white part of the eye) on either side. Its complex pattern can contain many distinctive features such as arching ligaments, furrows, ridges, crypts, rings, corona, freckles and a zigzag collarette [3]. The iris is a unique that there are no two iris alike, even twins. In addition, the iris patterns in the left and right eyes are different [12]. These characteristics make it attractive for use as a biometric feature to identify individuals. Iris recognition requires fives main steps: image capture; preprocessing, and segmentation (extraction the iris from the image of the eye area), and normalization (transform the iris in a polar coordinate to get rectangular image; feature extraction, which generates an iris template; and matching of iris templates and a make decision to rejection or acceptation (according to threshold) . In this steps; In order to assess the performance of biometric system we use two types of commonly used measures, the false accept rate (FAR) and the false reject rate (FRR), and the equal error rate (EER).

In this paper we developed a new algorithm od iris recognition include all this steps and we use the data base CASIA version 1.0 for testing.

The paper is organized as follows. In Section 2, some well known previous works are described. Then the outline of the proposed algorithm is presented in Section 3. And in the Section 4 the experimental setting and results are provided. In the Section 5 some discussions and conclusion are given.

II. Previous Works

Several methods have been proposed for iris recognition. Daugman [1], [2] first proposed an algorithm for iris recognition. His algorithm is based on Iris Codes. Integrodifferential operators are used to detect the centre and diameter of the iris. The image is converted from cartesian to polar transform and rectangular representation of the region of interest is generated. Feature extraction algorithm uses the complex valued 2D Gabor wavelets [1], [2] to generate the iris codes which are then matched using Hamming Distance. The algorithm gives the accuracy of more than 99.99%. Also the time required for iris identification is less than one second. Wildes [6] used an isotropic band-pass decomposition derived from the application of Laplacian of Gaussian filters to the image data. He used the first derivative of image intensity to find the location of edges corresponding to the borders of the iris. Wilde's system explicitly models the upper and lower eyelids with parabolic arcs whereas. The results of this system were good enough to recognize the individuals in minimum time period. Boashash and Boles [4] proposed a new approach based on zero-crossings wavelet transform. They first localized and normalized the iris by using edge detection and other well known computer vision algorithms. The zero-crossings of the wavelet transform are then calculated at various resolution levels over concentric

Manuscript received May 5, 2012; revised June 15, 2012.

Raida Hentati is with the the laboratory of computer and embedded Systems (CES), Tunisia (e-mail: Raida.Hentati@enis.mu.tn).

circles on the iris. The resulting one dimensional (1D) signals are then compared with the model features using different dissimilarity function. The algorithm is invariant to translation, rotation, scale and illumination and can handle the noisy conditions as well.

The previous work didn't look at a unified and free database to provide recognition rates and performances published in the literature, comparing them seems not to be trivial. In this work we propose topological information based on these algorithms, a processing step is presented to reduce the error rate. The algorithm is tested on the CASIA iris image database.

III. The Proposed Approach

The iris recognition algorithm developed three main steps; preprocessing and segmentation, encoding and matching.

The first step, preprocessing and segmentation. It consist on extracts the iris from the image. Like any algorithm that depends on computer vision execute, this part of the algorithm requires the most accuracy for there to be any chance of success in the later steps. Next, using Gabor filter to generate the iris template. A template is a binary vector that uniquely represents the information contained in the iris. Finally, matching applying the hamming distance beteewen two iris codes.

In the experimental works, we use CASIA data base version 1.0. Which contains 756 irises (eyes) of 108 subjects (7 different images for each subject). Each iris image is greyscale. Fig. 2 shows examples of images CASIA data base

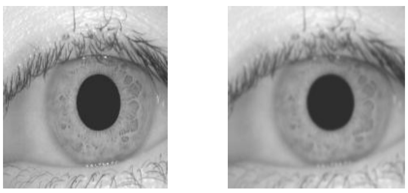
Fig. 1 Examples of images CASIA data base.

A. Iris Edge Detection

The segmentation process must properly extract the iris from the image. The iris is bounded by the pupil at the inner radius and the limbic boundary at the outer radius. Finding these boundaries begins with finding the pupil since it is assumed to be the easiest part of the image to segment with the assumption that it is simply a large black circle somewhere in the image. We are used a filter smoothing. Then Hough transform is detailed later.

1) Smoothing:

To reduce the effect of noise in iris images, we used a Gaussian filter. We used the same filter, will crush the black colour in eyelashes and retain those corresponding only to the pupil. Fig. 3 presents an image of the original eye and the result after filtering.



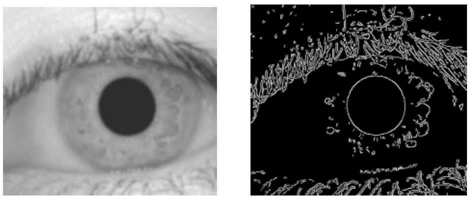
(a) (b)

Fig. 2. Application of Gaussian: (a) Original image (b) filtered image.

At this stage, the pupil is a black hole inside the iris almost circular. In acquisition near infrared, this region can be regarded as the region with stronger contrast.

2) Canny

Several methods of edge detection can be used. In our algorithm, we used the canny filter for the first part and the Sobel detector for the second part. Fig. 3 shows the outline of Canny applied to an image of the eye of the CASIA database.



(a) (b)

Fig. 3. Edge detection of image: (A) Filtered image (b) Canny edge.

3) Hough Transform

The Hough transform [5] is a technique which can be used to isolate features of a particular shape within an image. Hough transform is most commonly used for the detection of regular curves such as lines, circles, ellipses, etc. The main advantage of the Hough transform technique is tolerant of gaps in feature boundary descriptions and is relatively unaffected by image noise. We used the Hough transform from tow times. The first time to detection the pupil and the second time to detect iris.

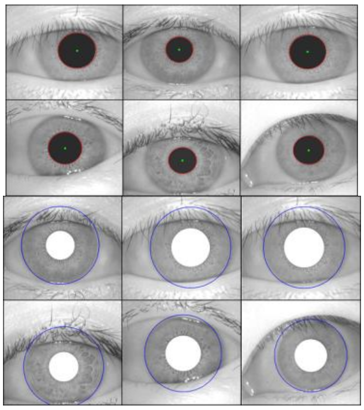
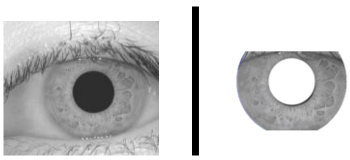


Fig. 4. Examples of the result of the pupil detection and the iris detection.

4) Insulation of the Eyelids and Eyelashes

Different noise may be present in the imaged eyes such as, the texture of the iris may be covered by eyelids and eyelashes. These noises can be due to the presence of eyelids when the eye opening or the presence of eyelashes with the irregular shape and random position. This problem make a very difficult to detect the iris. Up to 60% of the texture of the iris may be obscured by this kind of noise. We have eliminated the noise by tracing horizontals lines in area of eyelids and eyelashes and that result in Fig. 5



(a) (b)

Fig. 5. Removed eyelid and eyelash regions: (a) Original image (b) Iris extracts.

B. Encoding

First, we mapped the iris to a rectangle Daugman's rubber sheet model[1]. Then, we applied Gabor filter to extract the iris code.

C. Matching

Iris encodings can be compared by computing a Hamming distance between them. This distance between two iris codes, is calculated (HD) according to a threshold (S) the decision is
if HD>S => client
if HD<S => impostor

IV. Experimental Results

We used a Windows XP, which includes the Microsoft Visual Studio 2005 and Image Processing Tool: OpenCV Library (Open Source Computer Vision Library) is a library of image processing and computer vision in C / C + +, proposed by Intel for Windows and Linux. We tested the technique described above with database CASIA version 1.0 containing 756 images. Fig. 6 shows the different steps of the iris segmentation

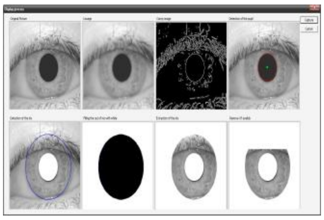


Fig. 6. The different step of the iris segmentation.

The success rate is around 92% with a running time between 0.092 and 0.290 seconds for each image of the iris. The table I Summarizes the execution time measured for each step of the algorithm.

TABLE I: Summary of Execution Times of IRIS Algorithm.

Modules	execution time (ms)	% of Total Time
Smoothing	5	3,22
Canny	13	8.38
Deletion of the pupil	19	12.25
Remove the pupil	7	4.51
Deletion of the pupil		
Filling the black iris	15	9.6
Filling the black iris		
Fill the outer part of the iris in white	18	11.61
Extraction the iris	9	5.80
Removal of eyelashes	23	14.83
Encoding	34	21.93
Matching	12	7.74
Total Time	155	

Each step of the algorithm requires varying times of execution. Depending on the complexity function in each module. Encoding step can require the most time. But the major part of the algorithm is in preprocessing and the segmentation process. To accurately detect the location of an iris an image. We note that, computational workload of this application is too much unbalanced. Matching execution time is essentially negligible. We choise the threshold. Then we apply this threshold to the similarity scores to generate computations of the False Rejection Rate (FRR) and False Acceptance Rate (FAR) as the threshold is varied. Finally, plotting FAR vs. FRR generates a Receiver Operating Characteristic (ROC) curve, which specifies the FRR for a given FAR (or vice versa) using a given recognition algorithm.. In Fig. 7 is plotted the DET curve.

The EER point gives an idea of the balance provided between user convenience and security for an iris system that is utilized for some type of user access (physical or logical); we report the resulting accuracy when the FAR and the FRR are equal.

Verification rate is equal to 1-FRR, and gives indication of the percent of genuine matches that are correctly identified

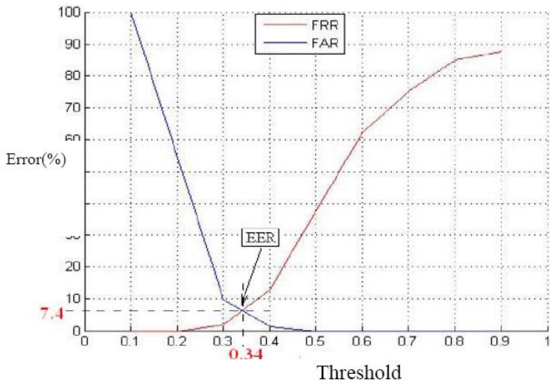


Fig. 7. Performance evaluation of the recognition algorithm.

We get an EER equal to 7.96% when threshold= 0.34. In Table II we compare our work with author Published works which use the some data base "CASIA"in term of accuracy

TABLE II: Comparison of Our Algorithm With Other Approaches in Term of Accuracy

Published Works	accuracy
[10]	86%
[11]	98.42%
Our work	92 %

We observed that the proposed algorithm has clearly less accuracy that the work in [11] and better that the work in [10]. In table III we compare the execution time of our work with author published work which use the some data base "CASIA

TABLE III: Comparison of Our Algorithm with Other Approaches

Published Works	execution time (ms)
[7]	450
Our work	155

We observed that the proposed methodology is clearly better that the work in [7] in term of execution time.

V. CONCLUSIONS

In this paper, we focused on the iris modality. The process of iris recognition containing three phases: preprocessing and segmentation, encoding and comparison. In the first phase we use filter smoothing and Hough transform. The Gabor filter using in the second phase and Hamming distance applying in the third phase. We used the C++language and library openCV to develop our algorithm. We tested it on the CASIA database. The iris verification processing is executed in 155ms and gives an overall accuracy of 92.04% with FAR of 1.58% and FRR of 2.34%.

In the future work we aim study other technique of recognition biometric such as gait, signature…also to use author international data base for testing such as ICE2005. And we plan also to extend our algorithm for a multimodal biometric system.

REFERENCES

[1] J. G. Daugman, "Biometric personal identification system based on iris analysis," U.S. Patent no. 5, pp. 291–560, 1994

[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, pp. 1148–1161, 1993.

[3] A. Muron and J. Pospisil, "The human iris structure and its usages," *Acta Univ. Palacki. Olomuc. Fac. Rerum Nat. Phys*., vol. 39, pp. 87–95, 2000.

[4] W. W. Boles and B. Boashash, "A human identification technique using images of the iris and wavelet transform," *IEEE Trans. on Signal Processing*, vol. 46, no. 4, pp. 1185–1188, Apr 1998.

[5] S. N. Srihari and V. Govindaraju "Analysis of textual images using the Hough transform," *Machine Vision and Applications* vol. 2, no. 3, pp. 141-153, DOI: 10.1007/BF01212455

[6] R. Wildes, J. Asmuth, G. Green, S. Hsu, R. Kolczynski, J. Matey, and S. McBride, "A machine-vision system for Iris recognition," *Machine Vision and Applications* vol. 9, pp. 1-8, 1996.

[7] C.-L. Tisse, L. Martin, L. Torres, and M. Robert, "Person identification technique using human Iris recognition telecommun," *Res. Inst.*, vol. 33, no. 2, pp. 61–70, Jun. 2001.

[8] L. Ma,T. Tan,Y. Wang, and D. Zhang, "Personal identification based on iris texture Analysis," *IEEE Trans.on pattern Analysis and Machine Intelligence*, vol. 25, pp.1519-1533. 2003

[9] X. Yuan and P. Shi, "Iris feature extraction using 2-D phase congruency," in *Proc. Third Int. Conf. Inf. Technol. Appl. (ICITA)*, Sydney,Australia, Jul. 2005, vol. 33, pp. 437–441.

[10] J, Y. Zuo, N. D. Kalka, and N. A. Schmid, "West virginia univ., morgantown," *A Robust IRIS Segmentation Procedure for Unconstrained Subject Presentation* Sept. 19 2006-Aug. 21 2006, pp. 1 - 6

[11] G. Z. Xu, Z. F. Zhang, Y. D. Ma, "Sch. of Inf. Sci. and Eng., Lanzhou Univ, Pattern Recognition," ICPR 2006. *18th International Conference* on Septembre 2006, pp. 505 – 508, 2006.

[12] A. Jain, "Biometric knowledge," In *Pattern Recognition and Image Processing Lab*, Michigan State University, 2005.

Raida Hentati received electrical engineering degree from the National School of Engineering of Sfax (ENIS) in 2007, and her MS degree in Computer Engineering from the University of Sfax in 2008. She is currently researcher in the laboratory of computer and embedded Systems (CES), Tunisia. Her research interests include signal and image processing, hardware implementation using FPGA, embedded systems technology