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# Fast Iris Recognition

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***Abstract*** *– The purpose of this paper is to achieve a system with fast response. Necessary pre-processing to achieve the feature extraction stage are image segmentation, image normalization, image quality improvement and image denoising. After above steps we need to extract features and encode them .in this paper we used Symlet4 wavelet transform for extract features. Then we propose two algorithms for fast response of identification system. Our first suggestion is to convert all database two classes. Anyone who wants to confirm identify, import their code and so all details converted into two classes .someone who wants to confirm identify is a class and remaining data is another class. The second proposed approach is using a threshold for similarity measure.*

***Keywords****: Contourlet transform, iris recognition, Symlet, Gauss-Laplace, normalized, segmentation*

ORIGINAL ARTICLE

## INTRODUCTION

Today, one of the most controversial issues is verify identity. Identification of individuals has many applications. One of the important parameters in the identification is the time taken for processing. Identification based on iris images in this paper have been discussed, in this type of identification must be done registration for each person. Then a person can be read by the system identification and authentication. Individual identified by the system performed the iris image into an existing database system and then compared with the whole class and then the result is unknown. This method is used need a lot of time because of the high number of classes. In this paper propose methods have a system that requires less time to respond. Our system is applicable to cases where less time is needed to confirm a person. The algorithm of Daugman [1-2] is the best admittedly at present, but this algorithm needs to process the two-dimensional information of the texture, and increases feature extraction time. Also, this algorithm has not solved the problem of revolving invariability, and uses the enormous redundancy of the iris texture characteristics, neglects this problem by the test statistical data. Wildes [3] has used the Gauss-Laplace filter to decompose the iris image under the different resolution, and carries on the correlation comparison for the corresponding images, the computation is huge. Boles and Boashash [4] has proposed a novel iris recognition algorithm based on zero-crossing detection of the wavelet transform. This method has only obtained the limited results in the small samples, and this algorithm is sensitive to the grey value changes, thus recognition rate is lower.

In Section 2 we review the necessary preprocessing. Normalization, denoising, enhancement, and segmentation are preprocessing that needed for iris recognition. In Section 3, we describe feature extraction by wavelet Symlet. Section 4 is Classes divide and how to achieve a rapid response by the system and check the results. Section 5 is contains the conclusion.

## PREPROCESSING

We need a series of preprocessing for preparing the input image in order to feature extraction. Pre-Processing explained in this part of paper.

### *A. Segmentation*

In Fig. 1, some images from CASIA database are presented. Iris is the part of eye that surrounds the pupil. Form eye image, only iris area is used for identification. For convenience, this part should be separated from the total eye image. There are many different ways to separate iris from the eye image.

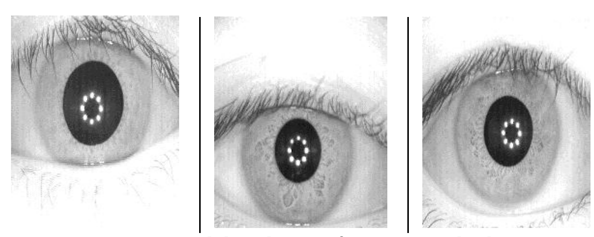

Fig. 1 - Original digital image from CASIA database

In this paper, we use Hough transform [3] and Canny edge detector [3] for iris segmentation. Edge is where the

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image begins or ends. Edge has no thickness. We have used Canny the edge detector in order to algorithm performance.

Canny edge detector is composed of three stages. Noise attenuation is the first step. Noise could damage the image edge. The two dimensional image and the Gaussian window convolve are used in noise attenuation. The second step is to specify the edge. Gradient image was used for this purpose. Each region with a higher gradient is chosen as the edge.

The third and final step is to remove points that are unlikely to be the edge. To do so, we used a different scale. We can use other operators such as Sobel edge detector or Laplacian detector. In this algorithm, to specify the iris and them segmentation we have benefited from Hough transform. This transformation can yield regular shapes from the image. To find a circle in the iris image, we find the edge image using an edge detection algorithm. Then we consider the circle equation such as following parametric form:

$$(x-a)^2 + (y-b)^2 = r^2 \quad (1)$$

In this equation (a, b) represent the coordinate of the circle center and r is circle radius. In this algorithm, we have benefited from canny edge detector and Hough transform in order to find the internal and external boundaries of iris. We have used canny edge detector to find the bottom and top eyelids in the picture. Fig. 2 shows the images segmentation as well as the internal and external boundaries of the iris. In Fig. 3 denoising has been done by blacking that the aria creating the noise. This deleted area has no value.

*B. Normalization*

After the image segmentation and determining, the iris area should be separated from the total picture. To identify and compare the iris area, the circular iris requires to be converted to coordinate that have a fixed dimensions. This feature makes the comparison practical. So far many articles have used Daugman's [1-2] method for normalization. In this paper the Daugman article has been cited for iris normalization.

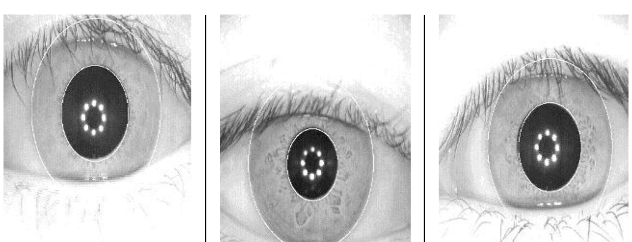


Fig. 2 - Image segmentation

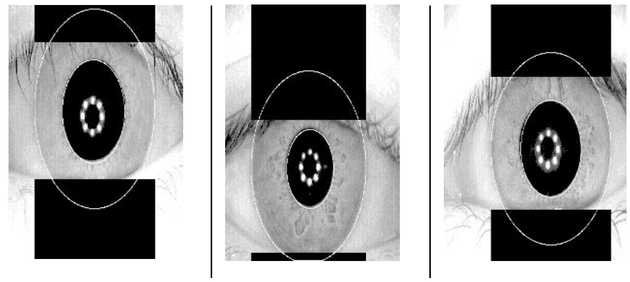


Fig. 3 - Image denoising with black area

Daugman method, works in a way that provides points in the iris converted to pair with corresponding points in polar coordinates (r, θ) in which r is radial distance (0, 1) and θ is the angular field [0, 2π]. Iris mapping from Cartesian coordinates to normalized coordinates of the non-polar center are described by the following equations:

$$I\left(x(r,\theta), y(r,\theta)\right) \rightarrow I(r,\theta) \quad (2)$$

$$x(r,\theta) = (1-r)X_p(\theta) + rX_l(\theta) \quad (3)$$

$$y(r,\theta) = (1-r)Y_p(\theta) + rY_l(\theta) \quad (4)$$

In which *I(x, y)* is iris area in the input image, (r, θ) is normalized polar coordinates, (x, y) Cartesian coordinates of input points, $X_l$, $Y_l$, $X_p$, $Y_p$ are the coordinates of the points on the pupil and iris boundaries are in order θ.

Consider the pupil center as reference point and internal and external boundaries of the iris area be mapped as a band. This model encompasses issues such as enlargement of the iris change in ambient light and the incompatibility of the iris in the pictures. Fig. 4 illustrates how to convert an iris circular to a band with arbitrary dimensions.

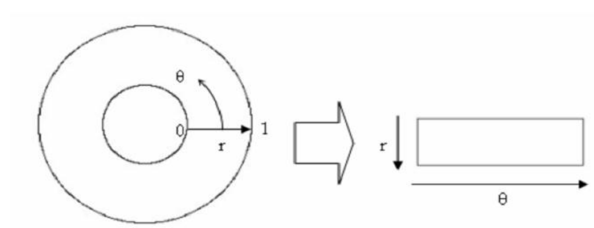



Fig. 4 - Show how converts polar coordinate to Cartesian coordinate.

In this paper we mapped iris area on the band area 64×512 (respectively, in order *r*, θ) and the pupil center considered as a reference point. Since the pupil and iris in most cases are eccentric, the mapping requires a new scale, upon these two different centers. This mapping is expressed as follows:

$$r' = \sqrt{\alpha} \pm \sqrt{\alpha\beta^2 - \alpha - r_l^2} \quad (5)$$

$$\alpha = O_x^2 + O_y^2 \quad (6)$$

$$\beta = \cos\left(\pi - \arctan(\frac{O_y}{O_x}) - \theta\right) \qquad (7)$$

In these formulas the distance between the edge of the pupil and edge of the iris in the angel θ with r' and *r* represents the iris radius. In this equation $O_x$ and $O_y$ represent pupil center and iris center respectively (Fig. 5). Fig. 6 shows some examples of the normalized image.

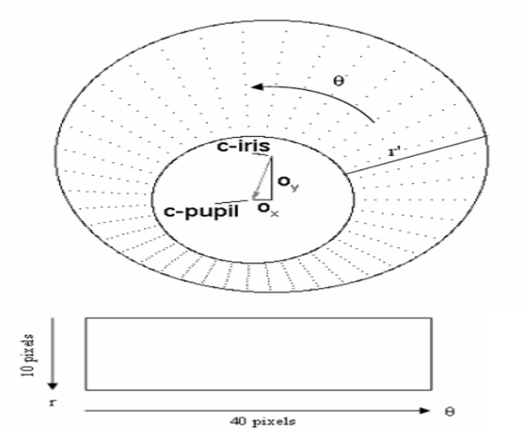



Fig.5 Shows iris and pupil not center and how mapping process

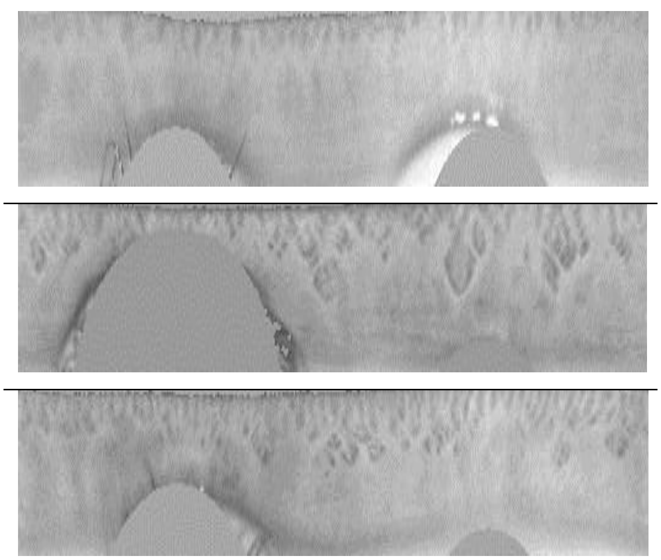


Fig. 6 - Some normalized image.

*C. Denoising*

We denoised normalized image to enhance quality of it and also deal with the possible noise that are added to image .In this paper, we denoised normalized images using the Contourlet transform [5]. Contourlet is an inseparable unidirectional two-dimensional transform that is used to describe curves and delicate details in the images. Contourlet expansions consist of a few basic functions which tend to have different shapes and scales (non-isotropic) in different directions. Having a set of adjustable basic functions, Contourlet transform efficiently represents those flat contours that are the main components of every normal image In contrast to other transforms where the convergence precedes the discreteness, Contourlet transform starts from a discrete domain with the help of filter banks and then converges to a continuous domain, through a multi-resolution analytical framework. Contourlet transform composes two main parts: Laplacian pyramid (LP) and Directional filter banks (DFB). The original image is converted into 2 images by LP; Low-pass image and band-pass image. In the next step, each band-pass image is analyzed by DFB. Multi directional and multi scale analysis of the image is obtained by repeating the aforementioned steps on the low pass image Result of Contourlet transform is better for iris image denoising. We have added noise manually to the normalized iris image in order to prove this claim. Then we denoise noisy image using the Gaussian filter and Contourlet. In order to compare the performance of different methods in image denoising, we calculate Peak Signal-To-Noise (PSNR) of denoised image of different methods. As Fig. 7 shows the images which denoised using Contourlet have grater peak signal to noise ratio.

## FEATURE EXTRACTION

In this paper, we used Symlet4 wavelet transform to extract images feature. We have applied 3 levels wavelet Symlet transform for normalized image. Fig. 8 shows Symlet wavelet level on the image.

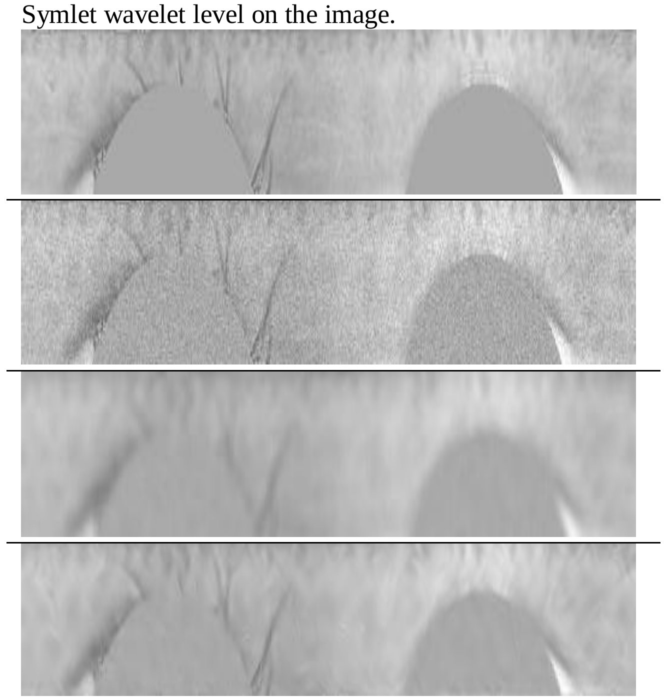


Fig. 7 - From up to down include: original image, image noise, denoising with Gaussian filter, PSNR= 33.6489dB, denoising with Contourlet, PSNR= 34.49dB.

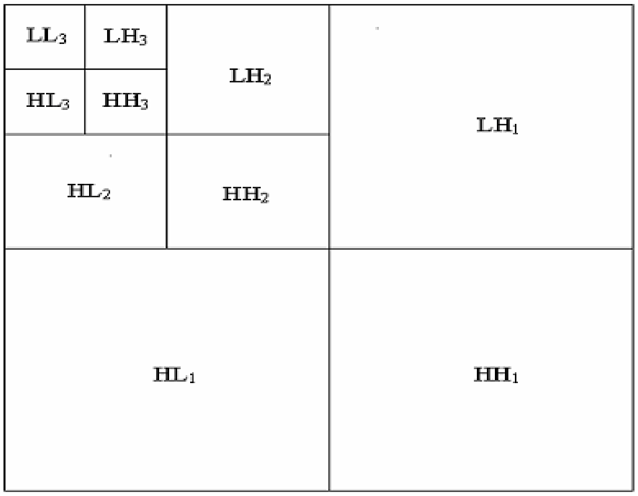
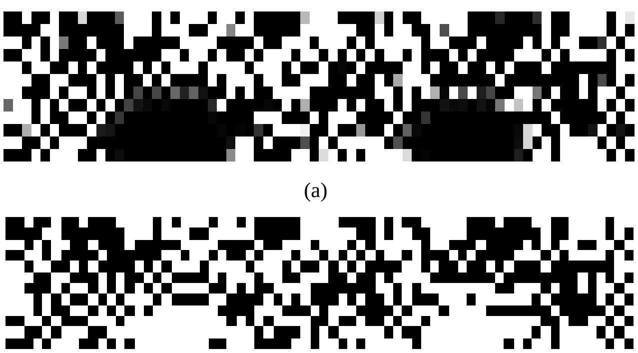



Fig. 8 - Apply 3 resolutions Symlet wavelet.

We have code diagonal output after three times taking wavelet. If a pixel value is higher than zero, we assume 1and if a pixel value is lower than zero, we assume 0. Fig. 9 shows images in the third level and also shows coded images.



(a)

(b)

Fig. 9- From up to down include diagonal in level 3 and its binary. (a) Diagonal in level 3, (b) Binary image from diagonal in level 3.

We have used the Hamming distance for comparing the generated code in the feature extraction stage. Hamming distance formula is as follows:

$$HD = \frac{1}{N}\sum_{i=1}^{N} X_i \oplus Y_i \qquad (8)$$

## DIVIDE INTO CLASSES IN ORDER TO ACHIEVE FASTER RESPONSE

Identification system based on iris images after receiving the input iris image of a person, system searches the person from all the people in its database and finds the desired person. Finally allow him to use of the system. It probably needs much processing time because system has classes as long as number of persons in the database. In some cases and uses, main issue is the person permitted or not. Our method is very good answers. For example, a country that have more than several millions people, needs to have several million classes so classification are not able to do that. In this paper we have suggested two offers for system rapid response. It is our first suggest for rapid response of system that first introduced himself to the system. In this method, after getting input image from system, the person should entered his personal identification code. After entering the code, system is converted into two classes that one is related to the person who entered the code and other class is related to the total data. With it all data is converted into two classes and respond time greatly reduced. This is our second method that input image compared with the total image in the data base. If this image is similar with one of database image the person is permitted to use the system. This method is requires a threshold similarity measure. This value is relative that has been achieve by try and error method, it is 0.2 if the minimum Hamming distance between input image and database image is less than 0.2 the person is permitted to use the system.

## CONCLUSION

In this paper, we have segmented iris image using by Hough transform and canny edge detector. Then we normalized image to improve quality using Contourlet transform. We use Symlet4 wavelet transform to features extraction. Three steps wavelet transform and binary diagonal output are the code of each image. If value is greater than 0, we assume 1 and if lower than 0, we assume 0. At first, we recommend to use two classes instead of several classes. In this way, all database classified into two classes by selecting target person. One class is the person's concerned and the remaining data in the database is the next class. The second proposed method is using a threshold for similarity measure. In this method, the input image is compared with the total data. When the hamming distance is less than the threshold number, it is known as an allowed person.

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