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Iris Image Denoising With Contourlet Transform

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Abstract *– The purpose in this paper is using a Contourlet transform and for denoising iris image. First in this paper we segment the image with Daugman methods. Then we try mapping the iris disk to 64×512 pixels with using convert polar coordinates to Cartesian. We applied preprocessing before the feature extraction that will improve the efficiency of image in feature extraction stage. The results show that the signal to noise when we used form Contourlet for image denoising is better that when we used other filter for image denoising.*

Keywords*: Contourlet, denoise, iris, segmentation.*

ORIGINAL ARTICLE

INTRODUCTION

People identification was considered from the ancient times. Nowadays, with increased security needs and progress information technology and machine vision progress, people identification with precision and speed was in improved. From the existing methods for identification, biometric methods are among the most secure methods. Other methods such as signatures or passports or ID cards can be counterfeited but identification methods based on biometric feature cannot counterfeit. Biometric methods identify individuals who are looking for ways to make the human body. Biometric method looks for ways that are relative to human body. This profile will be unique in each person that they aren't counterfeit. This methods needs to have a pre-registration stage. After a pre-registration process can be used frequently by confirm the identity system. Common biometric methods include: Using a finger print, Using a face image, Using a hand geometry, Using a sound, Using a palms Also Using an iris, And other items are available [1]. Fig. 1 shows a few of biometric methods data. Among these features, characteristics of iris pattern are shown better performance for identification. Iris of the eye is known as the outer color area around the eye and pupil are located in the midsection. Identification based on iris image includes analysis features that are in the colored texture surrounded by pupil and iris. For each person iris is unique because there are many different textures that are located around the pupil [2]. The device that is mode, imaging of a person with glasses or lenses has also been used and the device is able to identify these people [3]. Daugman [4-5] used intergro-differential operator to identify and finding the circular iris regions and pupil.

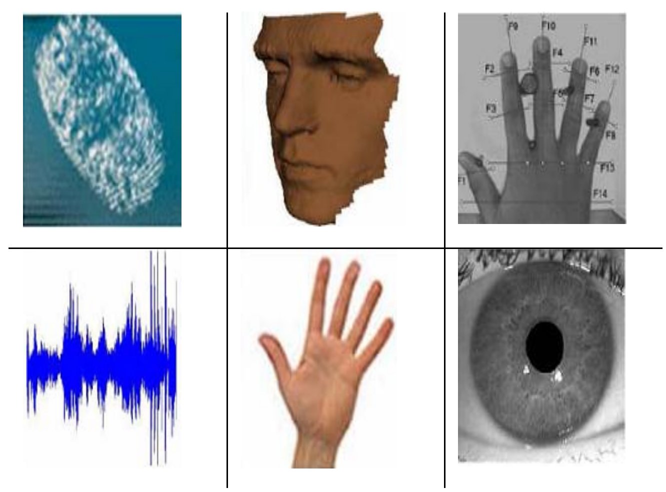

Fig.1 - Some pictures to demonstrate biometric method

Upper and lower eyelids are separated by two arcs. The integro-differentiol operator is as follows:

$$\max_{(r,x_c,y_c)} \left| G_r(r) \times \frac{\partial}{\partial r} \oint_{(r,x_c,y_c)} \frac{I(x,y)}{2\pi r} ds \right| \quad (1)$$

where $I(x, y)$ is the image of the eye, R is a search radius, $G(r)$ is a Gaussian function softener, S is circular boundary given by r, x_0, y_0. The operator searches a circular path that the highest intensity light changes with change radius and center (x, y) in circular contour. In addition, this method takes much time to find iris. Wildse [6] has done the segmentation and filtering using with histogram operator. And to find the edge of their eyelids, they can be modeled with horizontal parabolic. L. Ma and et al [7] were used the two dimensional Haar wavelet

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transform analysis in 4 stages. They converted fourth-level high frequency information as 87-bit code and be used a LVQ network for segmentation. Z. Sun and et al [8] were used multi-channel Gabor filters in order to feature extraction. Tisse and *et al*. [9] provided a method in order to image segmentation based on Hough transform and integro-diffrentiol operators. Computational time of Duagman's method. Tan and *et al*. [10] used ordinal measures in order to feature extraction from iris image for identification.

Iris image segmentation will be explained the in section 2. In section 3, iris image normalization is explained. We will investigate the use of the Contourlet transform for denoising in the normalized image in section 4. Section 5 contains experimental results and section 6 gives the conclusion of the paper.

SEGMENTATION

Iris has been between pupils and iris. Internal and external boundaries of the iris must be specified, because information is unique to the iris texture. For this purpose, we need to understand the edge concept. Edge is where the image begins or end. 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 in order to noise attenuation. The second step is to find out where it can be called the edge. That used the Gradient image. Each region has a higher gradient is chosen as the edge. The third and final step is to remove points that are a little likely to be the edge. For this we use a different scale. We can use other operators such as Sobel edge detector or Laplacian detector. In this algorithm, for specify the iris and them segmentation we have benefited from Hough transform. This transform can be extracted the regular shape 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:

$$\left(x-a\right)^2+\left(y-b\right)^2=r^2 \tag{2}$$

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 and the internal and external boundaries of the iris. Fig. 3 shows denoising has been done by blacked are that create the noise. This deleted area has no value.

NORMALIZATION

After the image segmentation and determine the iris area this area should be separated from the total picture. For

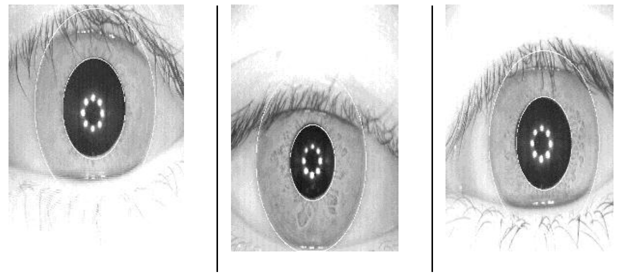

Fig. 2 - Image segmentation

Fig. 3 - Image denoising with black area

identification and compared the iris area, is required to the circular iris convert to coordinate that have a fixed dimensions.

This feature makes the comparison to be made. More articles from Daugman's [11] method have used for normalization. In this paper we citation Daugman article for iris normalization too. Daugman method, this is the case that available any points in the iris converted to a pair in polar coordinates (r, θ) in which r is radial distance (0, 1) and θ is the angular field [0, 2π]. Iris mapping of Cartesian coordinates to normalized coordinates of the non-polar center are described by the following equations

$$I\left(x(r,\theta),y(r,\theta)\right)\rightarrow I(r,\theta) \tag{3}$$

$$x(r,\theta)=(1-r)X_p(\theta)+rX_l(\theta) \tag{4}$$

$$y(r,\theta)=(1-r)Y_p(\theta)+rY_l(\theta) \tag{5}$$

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. Considering 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. 3 expressed how to convert an iris drive to band with arbitrary dimensions. In other words Fig. 4 states Daugman normal algorithm with image method.

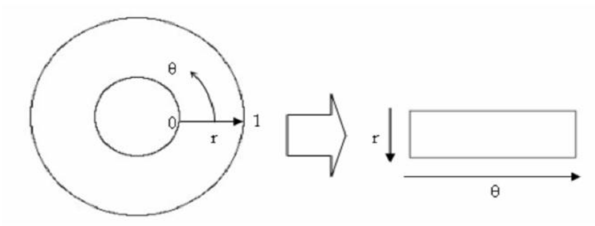

Fig. 4 - Show how converts polar coordinate to Cartesian coordinate.

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. In Fig. 5 some sample images that we see the normalization has been done on them.

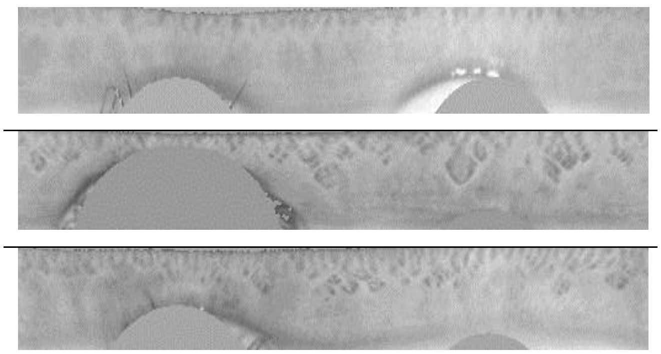

Fig. 5 - Normalized image

CONTOURLET FOR NARMALIZE IMAGE DENOISING

Normalized image have the noise that due to light intensity and other resources. For improve the work this noise should be eliminated. Before applied feature extraction methods to the normalized image and coding the image the operation denoising should be performed on the image. In this paper we applied Contourlet transform for the image denoising. Contourlet transform is an inseparable directional two-dimensional transform. That is used to describe curves and delicate details in the images. Contourlet expansions consist of basic function which tends to different shapes and scales (non-isotropic) in different directions. With this rich set of basis function, Contourlet transform describes flat contours that they are the main components of normal image. Although other transforms at first are made in a continuous domain and then they are discrete in order to sampled data, Contourlet transform starts from a discrete domain with the help of filter banks and then they converge to a continuous domain through a multi-resolution analytical from work. Contourlet transform is composed by 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 next step each band-pass image is analyzed by DFB. Multi directional and multi scale analysis of the image is obtained with repeating the listed steps on the low pass image [12]. A more transforms application is denoising of image. However, image quality is better with denoising of image. And will have better performance in order to feature extraction. In this paper, we have used Contourlet transform for denoising of image.

EXPERIMENTAL RESULTS

In this paper, we have used CASIA database [13]. This database is designed to test the identity of the iris recognition software. In this database is used of infrared waves to clarify the picture. These waves cause the removal of the reflected from the eye image. Thus we don't require the calculation of removing iris area that includes reflections.

We investigated denoising for different states. The first used Contourlet for eyes image before applied segmentation. Results show that this is good performance. The best results for denoising in this section occur when using Contourlet. Fig. 6 show the images that confirmer the above statements.

In the last step, we used Contourlet for denoising in normalized image. Fig. 7 shows the Contourlet for the normalized image denoising. Also we see the signal to noise ratio in the over figures. Obviously, the best signal to noise ratio for the image that be denoising with Contourlet. We have compared denoising results from the Contourlet other filters. Our method provides the best results.

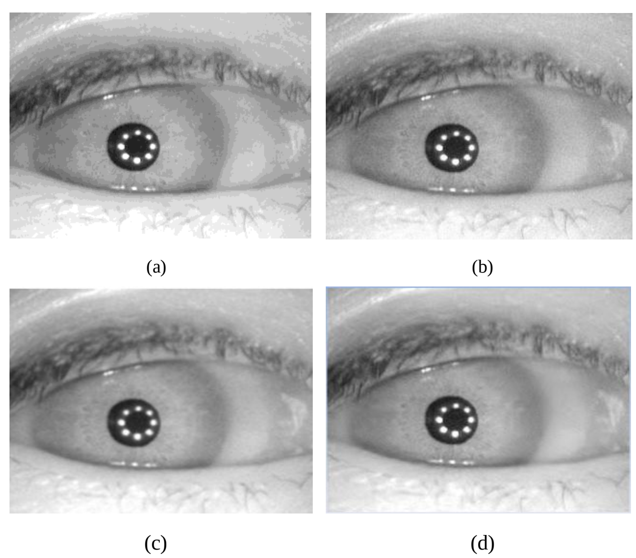

Fig. 6. (a) Original image, (b) Noisy image, variance = 20, (c) denoising with Gaussian filter PSNR = 36.4296dB, (d) denoising with contourlet PSNR = 36.5104dB

(a)

(b)

(c)

(d)

Fig. 7 - (a) Original image, (b) noisy image with variance equal to 20, (c) denoising image with Gaussian filter, 33.6489dB, (d) denoising image with contourlet transform, PSNR= 34.028dB.

CONCLUSION

In this paper, described beginning segmentation eye image. At this stage used the canny edge detector and Hough transform for segmentation the pupil and find the internal and external boundary of iris. In the next step with the pattern of Daugman's, we mapping the disk iris to the band with convert polar coordinates to the Cartesian coordinates. Then this band for the feature extraction needs to pre-process. We used Contourlet for denoise preprocessing. Denoising applied for normalized image. The results show that, signal to noise ratio is the maximum when we used Contourlet for image denoising.

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