International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

Conjuntival Vasculature based on Multiscale Multidirectional Operator for Human Recognition

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Abstract—In this paper, there is new part of the eye (sclera part of the eye) exposed as biometric or physical trait in biometric literature. Here, we deal with study of sclera region recognition by using ocular biometric modality for security, identification purpose, etc. In this paper, we used Conjunctival vasculature for authentication purpose. A biometric modality is increase rate of acceptance of visible white part of eye pattern, which is unique and accessible in visible spectrum. In feature extraction, multiscale multidirectional shear operator is used. Distance metrics are used for classification. In this paper, UBIRIS-V2 database and In-house database are used.

Keywords—UBIRIS-V2 Database, Conjunctival vasculature, shearlet Transform, Ocular biometrics, Distance metrics.

I. INTRODUCTION

Many applications of biometric modality are present for human or personal authentication technologies. The solution of biometric gives alternative passwords and different form of authentications. Recently, growth in smart phone has granted researcher to make and use of various biometrics as different applications of mobile. For personal identification and recognition purpose, there are many biometric traits. One of the stronger biometric method is iris biometric, drawback of iris recognition is from off-angle imaging and it is required near-infrared (NIR) spectrum [4].

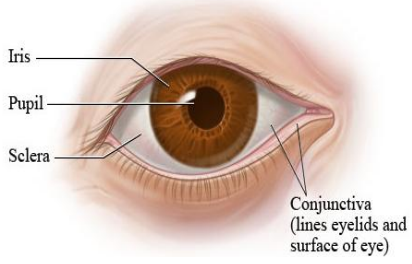

Fig.1: front view of the eye

Conjunctival Vasculature or sclera vein recognition is new method of ocular biometric modality which was introduced by Derakhshani et al [5]. In iris recognition, when iris becomes off angle gaze imaging with respect to the focal plane of the camera, then sclera part is disclosed. There is blood vessel pattern in conjunctival vasculature part in eye and it is required visible spectrum with cameras for capturing the images.

In previous work, there are various methods in image enhancement include contrast limited adaptive histogram enhancement (CLAHE), difference of Gaussian methods (DoG), Gabor based enhancement [6,7,8]. There are different methods for feature extraction methods contains wavelet, contourlet, minutia point, Gray level co-occurrence matrix (GLCM) methods, local binary pattern (LBP) method [6,7,8]. And for matching and classification, it contains Distance metrics, linear discriminant analysis(LDA) and neural networks(NN).

The remaining paper is shown as follows. Section II gives a summary of Literature survey. The sclera segmentation algorithm describes in section III. Theory of the Shearlet transform describes in section IV. Section V describes the classification. Sections VI and VII depicts the experimental procedures and results. Sections IX and X gives discussion, conclusions and future work.

II. LITERATURE SURVEY

In previous work for biomedical recognition, Conjunctival vasculature was established by Reza Derakhshani and Arun Ross in 2004 for biomedical purpose and pattern recognition [1]. There were many methods like contrast limited adaptive histogram enhancement method, Gabor based method used for Enhancement process and wavelet

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transform was also used for vascular pattern recognition [3,7]. For feature extraction, there was used Steady Illumination colour Local Ternary Patterns (SLcLTP) by Khatoon [7]. In Gottemukkala et al., the tiles are produced by dividing sclera part into small part and feature vector was formed by each tile which was extracted from statistical features [13]. In most of the research work for feature extraction, they were used different colour transform as input of the contourlet transform such as RGB (red, green, and blue layers) conversion, HSV (hue, saturation, and value) conversion, and YCbCr (luminance, chrominance blue, chrominance green) conversion and classification was performed using LDA. In Zhou et al.'s, Gabor filtering was used for vasculature enhancement and for vascular pattern matching, the line-like features were used. In conjunctival vasculature recognition, Das et al., we used Oriented Local Binary Patterns (OLBP) and dense sift for feature extraction [12].

III. METHODOLOGY

In this study, three main blocks are present, Image pre-processing, feature extraction, classification, comparison shown in below fig.2. Sclera segmentation is present in image pre-processing. Shearlet transform is used for purpose of feature extraction. And the distance metrics is used to classification techniques.

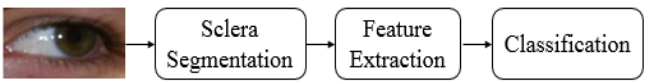

Fig.2 Basic block diagram

IV. SEGMENTATION OF SCLERA

Firstly, we collected In-house database and UBIRIS-V2 database for image pre-processing. The block diagram of sclera segmentation is shown in fig.3. In that first, database RGB images are converted into HSV images by using color space conversion. Then HSV image is given to the histogram equalization for adjusting image intensity to enhance contrast and this intensity should be ranging from 0 to L-1 which is same as human eye perceive color. This conversion image get binarized and original image is also given to the Low pass filtering. Filtering output (binary image) is given to the thresholding which is used to create rough mask. Small pixel of masking is removed by size thresholding and we get sclera mask. After that, the converged image is overlapped on sclera mask. Finally generates ROI of the image. This output is given to the feature extraction process.

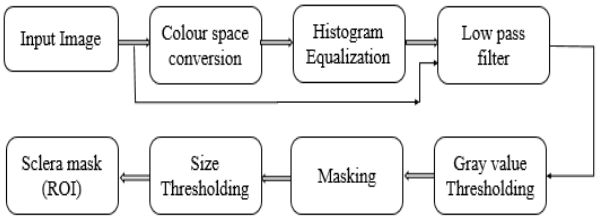

Fig. 3. Workflow of sclera segmentation

V. SHEARLET TRANSFORM

Shearlet transform is developed (in 2006) for processing of 2D and 3D data with a certain class of basis functions. Shearlet transform is particularly used to represent anisotropic features in multidimensional data. Wavelet transform is isotopically scaled and translated but for not all higher dimensional or multidimension. The generator functions are supported to a frame for $L^2(R^2)$. It is provided optimum sparse representations for cartoon- like function. The wavelet transform does not have ability to detect directionality properties. The shearlet transform is used to detect the directional information which is satisfied all those properties of optimized behavior of the direction information. To get over limitation of wavelet transform and increase directionality for the sparse representation. Shearlet has directionality properties for the sparse representation.

Additional shear operator is used to control the direction of shearlet. It is implement the rotation of the basis. This function has capability of reachingover various scales, orientations and locations. Shearlets consist of parabolic, scaling, translation and shear properties (directionality).Shearlet shows optimal behavior with respect to the detection of directional information. The shearlet is constant depends only on the maximum curvature of the singularity curve and maximum magnitudes and that approximate rate improves significantly. Shearlets provides

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www.ijetsr.com
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sparse approximation of anisotropic features for directional properties.

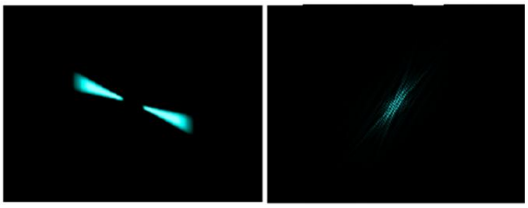


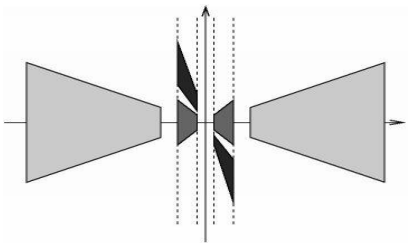
Fig 4:Shearlet transform in frequency and Spatial Domain

The continuous shearlet transform is a used for a 2 parameters dilation group as products of parabolic scaling and shear matrices. This transform depends on 3 parameters, such that scaling parameter ($a > 0$), Shear parameter ($s \epsilon R$), and translation parameter ($t \epsilon R^2$), and equation is given by,

$$\Psi_{a,s,t}(X) = a^{-3/4}\, \Psi((D_{a,s-1}(X-t))$$

Where, $D_{a,s}= [a,-a^{1/2}s;0, a^{1/2}]$.

The generating function Ψ is defined by,



$$\Psi(\xi_1,\xi_2) = \Psi_1(\xi_1)\Psi_2(\xi_2/\xi_1)$$

Fig 5:The continuous shearlets behavior in frequency domain.

Where, ψ_1 = a wavelet function, ψ_2= a bump function. And both are supported in frequency domain.

The shearlet transform is depends on the scaling (a), the shear (s) and the translation (t) parameters are defined as,

$SH_f(a,s,t) = \langle f, \psi_{a,s,t} \rangle$

As matrix coefficients of the unitary representation,

$(\sigma(a,s,t)\Psi)(x)= \Psi_{a,s,t}(x)=a^{-3/4}\, \Psi\, (D_{a,s}^{-1}(x-t))$

In continuous shearlet transform, the location parameter t does detect the location of singularities, whereas the shear parameter shows the direction perpendicular to the direction of the singularity. The directionality is apparent in time domain of the shearlets.

VI. CLASSIFICATION TECHNIQUES

In that, we used distance classifier for classification purpose. K-star distance classifier is used in this paper. K-star distance classifier is instance based learner classifier.K-star classifier algorithm performs classification has been carried out on several datasetscommonly used. In this paper, our dataset was partitioned into 2/3 training, 1/3 test. There are total 74 volunteer. Total 74 partitions were presented for our dataset.

VII. EXPERIMENTAL PROCEDURE

A. DATASET (UBIRIS-V2 DATABASE)

The UBIRIS -V2 dataset is captured RGB color images of the eye by using canon EOS 5D camera. These images were captured at different distances and on different angle which were in visible spectrum. There were total 261 volunteers in that approximately 46% female and 54% male present. The eye of each volunteer was move with respect to different angle of camera: upward, downward, left and right side at one meter, four meter and eight meter far distance. Total 15 image was captured per volunteer at different distances.

B. SEGMENTATION OF SCLERA REGION

Here, UBIRIS-V2 dataset (In-house database) is used. The images of these dataset are tested by segmentation algorithm.

In sclera segmentation, firstly RGB color image is converted into HSV image by color space conversion. After conversion, these converged image is binarized. This binarized image is given to the Histogram equalization which is used for adjusting contrast intensity level (0 to L-1). The equalized image and binarized image are provided to the low pass filter. Low pass filter is used to passes low frequency signals and attenuate high frequency signal. Filtering signal is applied to simple thresholding which is used to create rough mask. In that rough mask, there are some small number of pixels which is remove by size thresholding. After that, we got sclera mask. Then HSV image of mask is overlapped on sclera mask which gave region of interest of original image.

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The region of interest if original image is used for feature extraction.

C. FEATURE EXTRACTION

We got segmented region of the original image with particular size in pixels in sclera segmentation. For feature extraction, ROI image is down-sampled by pyramid reduction method. For feature extraction, shearlet transform is used. Then, decomposition level is changes from 3 to 5 level. There are some feature vectors i.e. mean, standard deviation, variance, entropy.

D. CLASSIFICATION

Distance metrics is used to measure similarity and dissimilarity of the eye images by using Euclidean distance for classification technique. In this paper, we are used K-star classifier and IB1 classifier which is used for measure distance between two pixels.

VIII. RESULT

The images of human eye are captured at various angle of the camera like, upward, downward, left and right side. These images are used from UBIRIS-V2 dataset. In Sclera segmentation, The RGB color images are converted into HSV images. Those HSV images are binarized by binarization which is applied to the histogram equalized image. To equalized image, Low pass filtering is applied and this image and equalized image are provided to the gray level thresholding which gives rough mask. Size thresholding is used to remove small pixels of sclera rough mask. Hereafter, sclera mask is overwritten into HSV image of original image. Finally, Region of interest of the original image is generated which is done by MATLAB coding. In this study, we used total 74 volunteers. In that, database divided into training and testing part.

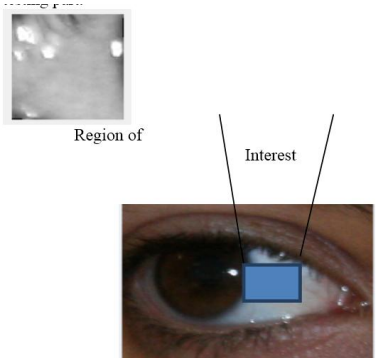

Fig 6: Selection of Region of Interest

After that, ROI is provided to the feature extraction. Shearlet transform is used for feature extraction which is multiscale multidirectional transform. In that shearlet transform, first ROI image is down-sampled by pyramid reduction method. For feature extraction, shearlet transform is used to measure shearlet coefficient which is shown in fig7 b). Those coefficients are used for classification technique to calculate some feature vectors.

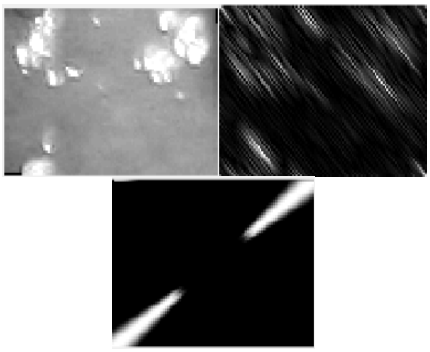

Fig 7: a) ROI of image b) Shearlet coefficient c) Shearlet transform

The feature vectors are mean, standard deviation, variance, entropy, etc. which is calculated by classification process. Here, we used various Distance classifier for classification purpose. By using distance classifier, we classified how many percent of images correctly classified or incorrectly classified. Also measure by using different number of combinations of feature vectors. The results of verification of classified image which is shown in Table .1 with different combinations of feature vectors.

TABLE 1: Verification of classified Images

Feature vectors	Accuracy
Mean, Standard Deviation, Variance, Entropy	100%
Mean, Standard Deviation, variance	86%
Mean, Standard Deviation, Entropy	100%
Mean,variance, Entropy	100%
Mean, Standard Deviation	77%
Standard Deviation, Variance	78%
Variance, Entropy	100%
Entropy, Mean	100%
Mean	43%
Standard Deviation	39%
Variance	42%
Entropy	38%

In this result, as feature vector reduce accuracy get reduce.

Another Experiment of this paper is that, we are used here different distance classifier for classification. These classifier gives more accuracy as compare to other classifiers. Next, as number of training images increases accuracy get decrease as per combination of feature vector. In classifier, accuracy is more and time complexity is less as compare to another classifier. For classification purpose, we used WEKA software.

VII. CONCLUSION AND FUTURE WORK

By using shearlet transform, we studied conjunctival vasculature pattern recognition for biometric which is successfully performed and evaluated on UBIRIS-V2 database. Experimental procedure proposed that multidirectional shearlet transform gives consistent vasculature sign which is used in recognition purpose. In this study, Instance based classifier gives more accurate classification by using WEKA software. It required less time to execute classification. In Future work, we use curvelet transform for feature extraction and same process follow for another transform. After that, compare both transform results.

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