Human Recognition using Conjunctival vasculature based on Multiscale Multidirectional operator

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Abstract: Recently, In biometric literature, the sclera of eye is new part of the eye to expose as biometric or physical trait. This paper deal with the implementation of sclera feature extraction on use of asocular biometric modality for authentication purpose. We use conjunctival vasculature part for identification and security purpose. A biometric modality is gaining acceptance of visible patterns of white part of the eye (sclera), which is state that, uniqueness and easy accessibility in the visible spectrum. After that for feature extraction, shearlet transform is used. For recognition and classification, we are used Distance metrics. Here, we are used in-house Database and UBIRIS-V2 Database.

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

I. INTRODUCTION

There are many applications based on biometrics modality based personal authentication technologies. There are different biometric traits (such as Fingerprints, ocular and face) for personal identification, recognition purpose. All the biometric modality, have to conformed to the well-known criteria universality, uniqueness, permanence, acceptability. Iris biometric is one of the strongest method in biometrics, which has drawback from off-angle imaging [4]. Near-infrared (NIR) spectrum is used in Iris recognition. Derakhshani et al was introduced new ocular biometric modality which is Conjunctival vasculature recognition or sclera vein recognition [5]. When iris is from “off angle imaging” with respect to the camera, then sclera part is reveal.

![Fig1: Front view of eye](Image)

Red blood vessel pattern on the sclera part is said to be conjunctival vasculature shown in fig.1, which is easily captured by visible spectrum using commercials cameras (digital cameras, smart phone etc.). Iniris recognition, Ocular biometrics is important because of their higher accuracies. There are most of the ocular biometrics uses textural information at pixel level from different part of eye of human body, that are the iris, conjunctival vasculature, and retina for authentication purpose. In previous studies for feature extraction, Local Binary Patterns (LBP), Wavelets, Contourlets, Gray Level Co-occurrence Matrix (GLCM), and minutia points are included. In Biometrics, Multivariate transforms have been implemented for feature extraction. Here, we used a multivariate Shearlet transform for feature extraction.

II. PREVIOUS WORK

In previous work, Reza Derakhshani and Arun Ross(2004) was introduced Conjunctival vasculature for biometric recognition and for pattern matching, also performed on ocular biometrics by including minutia points [5]. Conjunctival vascular pattern, Contrast Limited Adaptive Histogram Enhancement (CLAHE) method and Gabor based method were used for Image Enhancement. And wavelet coefficients are required for vascular pattern matching by Derakhshani et al and chiraltmeanu [6,2]. For feature extraction, they were used Gray level co-occurrence matrix (GLCM) method by Tankasala et al. In Ross Conjunctiva (2009), In this paper, they were performed and matching obtained under non-ideal conditions. Theaim that in an operational environment whenha viable biometric determined, then it was conjunctival vasculature [1]. In Gottemukkala et al., a tiles is produced by dividing sclera part into small part and feature vector was formed by each tiles 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 asRGB (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 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]. In Khatoon, for feature extraction, SteadyIllumination
colour Local Ternary Patterns (SLcLTP) was used in the YIQ colour space of the images in consideration [7].

III. METHODOLOGY

In any biometrics, there are three main blocks, Pre-processing, feature extraction, classification shown in fig.2. Image pre-processing basically include sclera segmentation algorithm.

Fig 2: Basic Block diagram

a) IMAGE PRE-PROCESSING

In this study, we used In-house (UBIRIS-V2 database) Database for sclera segmentation. The sclera segmentation algorithm has been tested on many images of UBIRIS-V2 database [9,10]. The flow of sclera segmentation is firstly performed colour space transformation from RGB conversion to HSV conversion. HSV colour space is similar to the way human eyes perceive colour. After these converged image is binarized. Histogram equalization apply to binarized image and Low pass filter is provide on histograms equalized image and original image. Rough mask is obtained by simple gray thresholding. A Small number of pixel is removed by size threshold, generate sclera mask. The HSV image of the sclera image are overlapped on sclera mask. For feature extraction, the input is from sclera mask.

Fig 3: Flowchart of Image Pre-processing (sclera segmentation)

IV. FEATURE EXTRACTION

Shearlets are allows to encode anisotropic features in multidirectional problem. Shearlets were used for the analysis and sparse approximation of functions in 2006. It is used to overcome drawback of wavelet transform and improves directionality for the sparse representation. Shearlet transform is based on multidimensional signals of sparse representation and used to extract of vascular pattern. Wavelet have capability of representing higher dimensional signal with isotropic features but not all multidimensional signals are strictly isotropic similar to the curvelet transform.

Additional shear operator is used to control the direction of shearlet. It is implement the rotation of the basis. This function has capability of ranging over various scales, orientations and locations. Shearlets consist of parabolic, scaling, translation and shear properties (directionality). Shearlet shows optimal behaviour 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 sparse approximation of anisotropic features for directional properties. The continuous Shearlet transform is mathematically representation for two dimensional signal is defined as [11],

\[ f \rightarrow \text{SH}_a f(a, s, t) = (f, \psi_{a,s,t}) \]

We use shear matrix \( S_a \) and dilation matrix \( A_a \) for \( d=2 \) are given,

\[ A_a= \begin{pmatrix} a & 0 \\ 0 & \frac{1}{a} \end{pmatrix}, \quad S_a= \begin{pmatrix} 1 & s \\ 0 & 1 \end{pmatrix}, \quad a \in \mathbb{R}^+ \]

The Shearlets is forthcome by dilation, shear and translation of a function \( \psi \in L^2(\mathbb{R}^2) \) and shearlet is in spatial domain and is given as,

\[ \psi_{a,s,t}(x) = a^{-3/4} \psi(A^{-1} S^{-1} (x-t)) \]

The shearlet in frequency domain and is given as,

\[ \psi_{a,s,t}(\omega) = a^{3/2} e^{-2\pi i a\omega} \psi(0,0) \]

Fig 5: Shearlet transform in frequency and Spatial Domain
V. CLASSIFICATION TECHNIQUE

In Image processing, the distance between two pixels in an image is calculate by Distance metrics. Distance metrics is defined as the distance between of two pixels in metrics. It is used as cost or error functions to optimized problem. In distance metrics, there are many methods to calculate distance but in this paper, we are included Euclidian distance.

Euclidian Distance: It is used for straight line distance. If two pixels are \((a_1,b_1)\) and \((a_2,b_2)\) then, the Euclidian distance is given by,

\[ D_{\text{euclid}} = \sqrt{(a_2 - a_1)^2 + (b_2 - b_1)^2} \]

And squared Euclidian distance is,

\[ D^2_{\text{euclid}} = (a_2 - a_1)^2 + (b_2 - b_1)^2 \]

VI. EXPERIMENTAL PROCEDURE

A. DATASET (UBIRIS-V2 DATABASE)

The Canon EOS 5D is used to captured RGB colour images of the eye in UBIRIS-V2 Database. At different distances, The images were captured on the movement and the visible spectrum (non-constrained conditions). In UBIRIS-V2 Database, there are approximately 261 subjects in that 54% male and 46% female included, each subject was move their eye with respect to focal plane of the camera: frontal, upward, left side, and the right side at near (one meter), medium (four meter) and far distance (eight meter). Images are captured manually total 15 images per eye at different distances.

B. SEGMENTATION OF SCLERA REGION

In segmentation, we used In-house (UBIRIS-V2 database) Database. Here, we are tested on images of UBIRIS-V2 database for segmentation algorithm. The overflow of sclera segmentation is firstly performed colour space conversion from RGB colour image to HSV colour image. HSV colour space is similar to the way human eyes perceive colour. After these converged image is binarized. Histogram equalization apply to binarized image and Low pass filter is provide on histograms equalized image and original image. Rough mask is obtained by simple gray thresholding. A Small number of pixel is removed by size threshold, generate sclera mask. The HSV image of the sclera image are overlapped on sclera mask. We get region of interest images. These images are given to the further procedure feature extraction.

C. FEATURE EXTRACTION

After segmentation, we get segmented image (ROI image) with selected size in pixels. In Feature extraction, these segmented ROI images (with particular size in pixels) are used and these images are down-sampled by using image pyramid reduction method. Shearlet transform is used to extract features of segmented ROI images. After that, decomposition level is changes from 3 to 5. Element of a feature vector are considered on each band in the shearlet transform, such as standard deviation and entropy.

D. CLASSIFICATION

In this study, we used distance metrics to measure similarity and dissimilarity of the eye images by using Euclidean distance for classification technique.

VII. RESULTS

The eye images are taken from UBIRIS-V2 database and each images were captured at different angle of focal plane of the camera such as looking straight, looking up and down and looking right and left.

MATLAB coding for the pre-processing of the images was done. In pre-processing, these colour images are converted into HSV images. HSV images are created binarized images and given to histogram equalized image. LPF is applied to equalized image. Filtering image and histogram equalized image are given to the thresholding and by size thresholding, remove small pixels. sclera mask is generated then this mask is overlapped into HSV image. Finally, we got region of interest of eye images.

VIII. CONCLUSION AND FUTURE WORK

Through this paper, we studied recent biometric traits on conjunctival vasculature recognition. Accordingly, literature survey was done to learn about the current trends and the previous works in the field of aforesaid topic. Subsequently, a methodology was adopted based upon the literature study with certain modifications in the techniques discussed by various authors. Thus, with the help of Multi-scale multidirectional operator (Shearlet transform) based strategy is taken for further experimentation for the succeeding part of the project. Pre-processing of images was implemented / studied to understand the logic behind the algorithm and how to get ROI of the original eye images.
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