Human Identification Method: SCLERA

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Abstract- *The vein structure of the sclera is unique for each person and stable over time and can be used for identifying human. Therefore, the sclera vein pattern can be used for a useful biometric feature. In this paper we propose a new concept for human identification i.e. Sclera Recognition. Sclera vein pattern recognition can face a several challenges like: the vein structure moves as the eye moves, low image quality, multilayered structure and thickness of the sclera vein changes with the excitement level of the human body. There are several contribution. First we Propose the new approach for human ID i.e. Sclera Recognition. Second we developed segmentation method for both the grayscale and color images. Third we design the Gabor wavelet based sclera pattern enhancement method and finally, we proposed Line descriptor based feature extraction, registration, and matching method.*

Keywords- Sclera Vein Recognition, Sclera Feature Matching, Sclera Matching, Sclera Segmentation, Feature Extraction, Finger Vein Recognition, Multimodal Biometrics.

I. INTRODUCTION

Biometric is used for identifying and verifying the person identity by the use of their physical, biological and behavioral traits. The blood vessel structure of sclera is formed randomly and it is unique to each person [1]. The sclera is the white portion of the eye and is made up of four layer of tissues i.e. episclera, stroma, lamina fusca, and endothelium [2], [3]. The vein patterns seen in the sclera region is unique to each person in the visible wavelength [4]. Twins also have different blood vessel structure and therefore it is well suited for human identification [5]. Recently it is very important to authenticate person identity to prevent fraudulent activity such as accessing sensitive information, creating false identities etc [6]. Therefore to resolve this problem, the biometric system is secured for user identification. Sclera recognition is a new approach which provides higher accuracy than the Iris recognition [7].

II. PROPOSED METHODOLOGY

The design of a multimodal biometric system is strongly dependent on the application scenario. A number of multimodal biometric systems have been proposed but they are differ from one another in terms of their architecture, the number and choice of biometric modalities, the level at which evidence is accumulated and the methods used for the integration . The proposed system adopts multiple biometric traits of an individual or user, to establish their identity. From the Fig.1 the proposed system architecture shows initially in enrollment, input data eye image have to be register. Then the eye image is segmented to obtain the enhanced vein patterns. Then feature extraction takes place to drive the vein features of sclera and stored into database with respect to account number. Then the input image matches with stored image. From the matching decision to identify the authorized person. Required proof details are registered with personal details of the user.

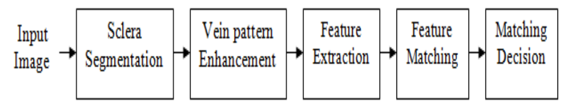


Fig. 1 Architecture of proposed system

A. Sclera Vein Segmentation

Segmentation is the one of the steps in image processing. It divides an image into multiple parts so that we can extract the more accurate image attributes. In this project the input eye image have to segment for getting the sclera vein pattern for authentication purpose.

B. Estimation of Sclera Area

First the pre-processing step includes task to convert the input color image to gray scale image for easy computation. Then there are two classes in an input eye image, foreground (object) and background, which can be separated into two classes by the intensity. The hue of the sclera area should have low hue (about bottom 1/3), low saturation (bottom 2/5), and high intensity (top 2/3). Therefore, the following heuristic is developed:

$Result(x,y) = 1\ if\ H(x,y) \leq thh\ and$
$S(x,y) \leq ths\ and\ I(x,y) \leq thi$ -------1
Otherwise 0------2

C. Sclera Vessel Pattern Enhancement

The vessel structure in the sclera region is very difficult to see. The sclera vascular patterns are often blurry and/or have a very low contrast. To overcome this, it is important to enhance the vascular patterns. Therefore the Gabor filters is good approximations of the vision processes of the primary visual cortex. Because the vascular patterns could have multiple orientations, in this study, a bank of directional Gabor filters is used for vascular pattern enhancement.

The image is first filtered with Gabor filters with different orientations and scales-

$If(X,Y,Y,S) = I(X,Y) * G(X,Y,Y,S)$-----3

Where, $I(X,Y)$ is the original intensity image, $G(X,Y,V,S)$ is the Gabor-filtered image at orientation θ and scale s. Both θ and s are determined by the desired features to be extracted in the database being used. All the filtered images are fused together to generate vessel-boosted image $F(x,y)$.

$f(x,y) = \sqrt{\sum_{v\in\Theta}\sum_{s\in s}(If(x,y,v,s))If(x,y,v,s)^2}$------4

An adaptive threshold, based on the distribution of filtered pixel values, is used to determine a threshold to binaries the Gabor filtered image.

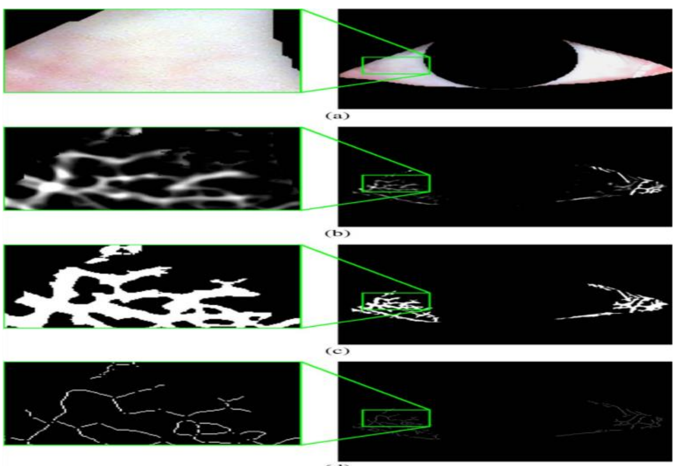


Fig. 2 Vessel patterns— before and after Gabor enhancement. (a) Segmented sclera region. (b) After Gabor enhancement (vessel-boosted image). (c) After thresholding (binary vessel image). (d) After morphological operations.

D. Feature or Vascular Pattern Extraction

In this study, binary morphological operations are used to thin the detected vein structure down to a single-pixel wide skeleton and remove the branch points. The line segments are then used to create a template for the vein structure. The segments are described by three quantities the segments ‘angle to some reference angle at the pupil‘s center, the segments distance to the pupil center, and the dominant angular orientation of the line segment. Fig.3 shows a visual description of the line descriptor.

A descriptor is

$$S = (\Theta r\ \Phi)T$$

The individual components of the line descriptor are calculated as,

$\Theta = \tan^{-1}\left(\frac{(yl-yi)}{(xl-xi)}\right)$, ---------5

$r = \sqrt{(yl-yi)^2 + (xl-xi)^2}$-----6-

$\Theta = \tan^{-1}\left(\frac{dy}{dx} f_{line}(x)\right)$--------7

Here $f_{line}(x)$ is the polynomial approximation of the line segment (xl, yl) is the center point of the line segment, (xi, yi) is the center of the detected iris, and S is the line descriptor.

Fig.4 shows Sclera Feature Extraction.

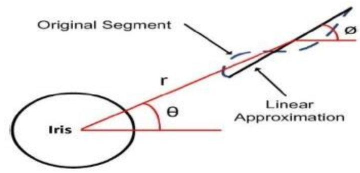
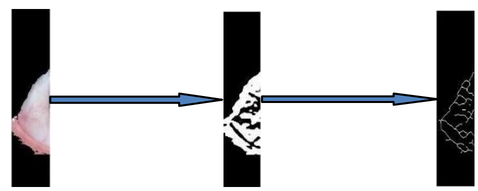


Fig. 3 Sketch of parameters of line segment descriptor.



Segmented Sclera. Gabor After morphological

Fig.4 Sclera Feature Extraction.

E. Sclera Feature Matching

The matching process consists of two steps:

i) Sclera Template Registration, and
ii) Sclera Template Matching.

i) Sclera Template Registration

The Sclera Template Registration process is done based on the random sample consensus (RANSAC)-type algorithm to estimate the best fit parameters for registration between two sclera vascular patterns. RANSAC is an iterative model-fitting method that can be robustly fit to the model, even in the given noise. To limit potential false accepts due to over-fitting, the patterns are registered as a set of points — the centers of the line segments that make up a template. The optimal registration used is the one that is used to minimize the minimum distance between the templates. This reduces the artificially introduced false accepts because it does not register the patterns using the same parameters used for matching. Therefore, the optimal registration and optimal matching can, and probably will, be different for templates that should not match. It also randomly chooses a scaling factor and a rotation value, based on a priori knowledge of the database. Using these values, it calculates the fitness value for the registration using these parameters. The two descriptors Sxi and Syj.

$$S_{xi} = \begin{pmatrix} \Theta xi \\ rxi \\ \Phi xi \end{pmatrix}$$
and

$$S_{yi} = \begin{pmatrix} \Theta yj \\ ryj \\ \Phi yj \end{pmatrix} \text{---------8}$$

Fig.5 Weighting image.

First, an offset vector is created using the shift offset and randomly determined scale and angular offset values

$$\varphi_0 = \begin{pmatrix} x0 \\ y0 \\ s0 \end{pmatrix} \text{---------------9}$$

Where

$$x_0 = r_{xi}cos\Theta_{xi} - r_{yj}cos\Theta_{yj}$$

And

$$y_0 = r_{xi}sin\Theta_{xi} - r_{yj}sin\Theta_{yj}$$

The fitness of two descriptors is the minimal summed pair-wise distance between the two descriptors given some offset vector. Where,

$$D(S_x, S_y) = argmin_{\varphi 0} D{\sim}(S_x, S_y, \varphi_0)$$

Where,

$$D{\sim}(S_x, S_y, \varphi_0) = \sum_{xi \in Test} minDist(f(S_{xi,} \ \ \varphi_0), S_y) \text{--------10}$$

Here, $f(S_{xi}, \varphi_0)$ is the function that applies the registration given the offset vector to a sclera line descriptor

$$f(S_{xi}, \varphi_0) = \begin{pmatrix} cos^{-1}\left(\frac{r_{xi}cos\Theta_{xi}+x_0}{s_0 r_{xi}}\right) \\ r_{xi}cos\Theta_{xi} + x_0 \\ \Phi_{xi} \end{pmatrix} \text{-----11}$$

The minimum pair wise distance is calculated using

$$minDist(S_{xi}S_y) = arjmin_j\{d(S_{xi}, s_{yj})\} \text{----12}$$

The distance between two points is calculated using

$$d(S_{xi}, S_{yj}) = \sqrt{(x_0)^2 + (y_0)^2} \text{-----------13}$$

Where Sxi the first descriptor used for registration, Syj is the second descriptor, is the set of offset parameter values that modifies the descriptor with the given offset values, s is the scaling factor, and ∅ is the rotation value.

ii) Sclera Template matching:

In this study, a new sclera template matching technique is introduced. This will increase the accuracy of sclera template matching without much increase in False Accept Rate (FAR). Fig.6 shows the matching technique.

Fig.6 Sclera Template Matching

After templates are registered, each line segment in the test template is compared with the line segments in the target template for matches are, segments and is the Euclidean distance between the segment descriptor center points ,is the matching distance threshold, and ∅ match is the matching angle threshold. The matching thresholds D_{match} and Φ_{match} were both determined empirically to be 5 pixels and 10◦, respectively.

Fig.7 Blood vessel enhanced image RGB eye image

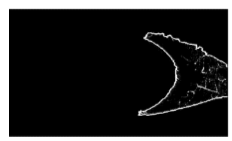


Fig.8 Blood vessel enhanced image

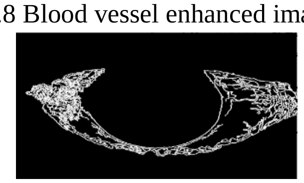


Fig.9Complete eye blood vessel enhanced image

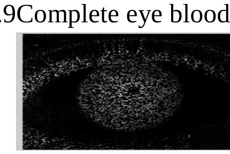


Fig.10. Filtered eye image

III. PROPOSED RESULT

After experimenting on all 10test cases, it is seen that this system can match accurately in 08 cases. The False accept rate was seen in 2 cases, but in those cases it also matches with its class trained dada. The result is shown in the Table.1.

Test Figure	**Matching Result**	**Status**
1	99.25	Matched

2	99	Matched
3	89	Matched
4	88	Matched
5	96	Matched
6	89	Matched
7	87	Matched
8	87	Matched
9	92	Matched
10	91	Matched

Table 1 Experimental result for total 10 test cases.

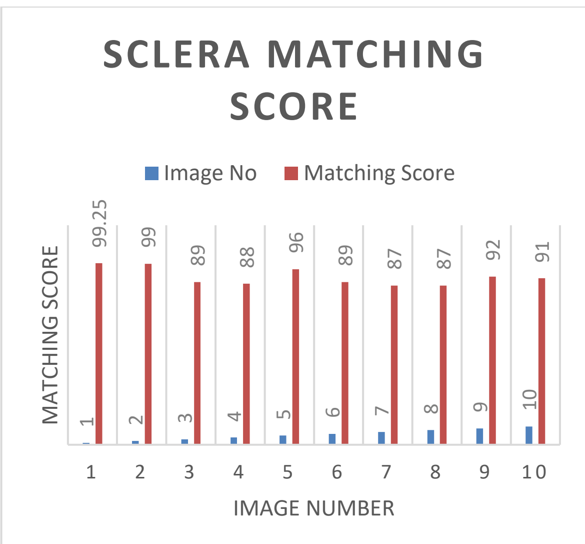


Fig.11 Matching Score of images

IV. ACCURACY CALCULATION

Based on the shown experiment results (Table 1) it is seen that the proposed system can recognize the test sclera with trained sclera 08 out of 10 cases. So, the calculated accuracy is,

$$\frac{8*100}{100} = 80\%$$

The metrics used for evaluation are False Acceptance rate (FAR) and False Rejection Rate (FRR).

$$FRR(n) = \frac{No.Of\ all\ rejection\ attempts\ for\ a\ qualified\ person\ n}{No.Of\ all\ verification\ attempts\ for\ a\ qualified\ person\ n}$$

$$FAR(n) = \frac{No.Of\ successful\ independent\ fraud\ attempt\ for\ a\ qualified\ pe}{No.Of\ all\ vindependent\ fraud\ attempt\ \ for\ a\ qualified\ perso}$$

FAR is calculated as [FP/(TN+FP)]*100%
FRR is calculated as [FN/(TP+FN)]*100%
And GAR is calculated as 1-FRP %
Where,
FP is the False Positive i.e. incorrectly rejected.
TP is the True Positive i.e. correctly rejected.
TN is the True Negative i.e. correctly rejected.
FN is the False Negative i.e. incorrectly rejected.

The FRR is the frequency that an authorized person is rejected access. The evaluation of sclera recognition was carried out with 100 images taken from UBIRIS database were grouped into ten users and the results are tabulated for FAR and FRR. Table I and figure.11 shows the resulted (FRR) as obtained for the proposed sclera vein and existing iris technique.

V. CONLUSION

This paper introduces completely automated system is developed which is accurately authenticate the users based on their sclera vein pattern. Experimental result shows that the sclera recognition improves the accuracy than the previous recognition techniques. The images acquired for the recognition process is obtained from UBIRIS database.

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