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Survey Paper on Sclera Segmentations Techniques

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ABSTRACT

Abstract—Due to extensive growth of internet, security of the internet is area of interest for the researchers. An efficient biometric trait these days are sclera blood vessels. Sclera is a white region in the eye, around the eyeball which contains blood vessel patterns that can be used for personal identification. In this paper we present the existing sclera segmentation methods and their working in with their limitations and ideas to enhance them.

Keywords

Sclera, Segmentation, Iris, Feature extraction, Classification.

I. Introduction

Sclera segmentation has become more important for biometrics related to the eye and iris. Sclera segmentation, however, has primarily been described as a part of a larger effort rather than being the subject of in-depth research[1]. The white, opaque regions of connective tissue and blood vessels in the eye are known as the sclera. The iris, the colorful tissue that encircles the pupil, is surrounded by this region of the eye [2].The sclera, as depicted in Figure 1, has a complex network of blood vessels with numerous layers and varied orientations. Consequently, it is believed that these blood vessels' distinguishing qualities are a bright factor for eye recognition in visible wavelength illumination [3].

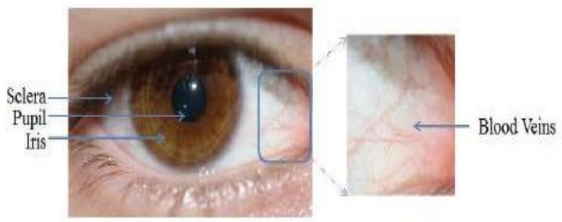

Fig1.Scelera Image

Table I compares several biometrics according to the following criteria: user cooperation [6], scalability to a large population [9], accuracy [4], stability [5], dependability [6], and identification (ID) and ID capabilities in a distance [8].

TABLE I
Comparison of Biometric Based techniques[3]

	Accuracy	Reliability	Stable	ID	ID in distance	User Co-op	Large Population
Fingerprint	High	Very high	Yes	Yes	No	Yes	Yes
Face	Medium	Medium	No	somewhat	somewhat	No	No
Iris	Very high	Very high	Yes	Yes	somewhat	Yes	Yes
Voice	Low	Low	No	No	--	No	No
Hand geometry	Low	Low	Yes[1]	No	--	Yes	No
Ear shape	Medium	Medium	Yes[1]	No	somewhat	Yes	No
Signature	Low	Low	No	No	--	Yes	No

[1]Patterns remain stable throughout adulthood in normal situations.

We can see from this table that Iris has a wide range of potential research topics. Sclera can be observed from a distance when illuminated with visible wavelength light.

The unique characteristics derived from the blood vessels within the sclera have drawn attention to the recognition of the sclera recently. Sclera detection, however, faces a number of difficulties due to wayward human poses, various iris look orientations, drastically varying distances at which eyes are photographed, and variations in lighting conditions.

The accurate segmentation of the sclera area, sclera vessel augmentation, and the extraction of judicial elements from the sclera vessel pattern for authentication and recognition are some of the issues in sclera recognition. The task becomes more difficult because the eyelid and eyelashes frequently block the view of the entire sclera. Moreover, different lighting conditions can change the appearance of the texture patterns by accentuating & attenuating various grey tones. Also the authentication system should work in real-time sothat extraction, representation and comparison of texture images should not consume large computational resources. After that, a classification system uses the mathematical model of the sclera texture to compare with other sclera images to identify specific individuals or recognise an individual.The structure of this essay is as follows. The history of the sclera and sclera segmentation methods are covered in Section II. We describe the shortcomings of the current systems in Section III, along with suggestions for improvements. In section IV, a conclusion is drawn.

II. Literature Survey

Derakhshani et al. [10] required manual segmentation of the sclera region. Their research looked into the viability of identifying people by their sclera's blood vessels. Then, utilizing wavelet-derived features and neural network classifiers, Derakhshani and Ross [11] examined a novel approach for representing and matching the texture of blood arteries. In [12], data from the blood vessels of the sclera were processed using a semi-automated sclera segmentation system in conjunction with an image enhancement and registration scheme. Based on a single skin-based segmentation in the RGB color space, Thomas et al.'s new automated method for sclera segmentation [13] was proposed. On the other hand, Local Binary Patterns (LBPs) were used in [14] to extract characteristics describing the blood veins in the sclera.

Zhou et al. [15] used bank of Gabor filters with a line descriptor to create a binary blood vessels skeleton map. A discrete Meyer wavelet filter banks and Local Directional Pattern (LDP) were used in [16] for blood vessel enhancement and feature extraction. Finally, Alkassar et al. [17] proposed a new sclera segmentation and occluded eye detection for sclera validation.

In a gaze tracking method, one of the earliest studies describing sclera segmentation uses a modified Self Organizing Map [18]. The technique requires first locating the iris border and then setting two control points that are inferred from the iris center and radius. The sclera border location is then precisely adjusted by utilizing the two control positions in an active contour model technique. It is recommended in [19] that conjunctiva vasculature be excluded from sclera recognition in favor of focusing just on the layer of sclera vein patterns, which are constant throughout time. The sclera segmentation method used in [19] makes the assumption that the images comprise frontal-looking eyes and that the location of the iris center is known. Two binary maps are produced based on observing non-skin area using RBG colour space & white colour using HSV colour space. Furthermore, the convex hull of the two masks is calculated and mixed to gain a final sclera region.

In [20], the authors investigated the Sclera vasculature using multiple wavelengths as a biometric modality. Using a sclera index measure, which is dependent on multispectral data—that is, the difference in green and near-infrared pixel intensities is greater for the sclera region—the sclera was segmented. [21] segments the sclera using a K-means clustering method. According to an assessment of sclera recognition techniques conducted in 2013 [22], the few systems currently in use for sclera segmentation rely on a number of different presumptions, such as the knowledge of the location of the iris center. A method for sclera segmentation based on fuzzy logic was proposed by Abhijit et al in 2014 [23].
A typical sclera biometric system is explained in Fig. 2.

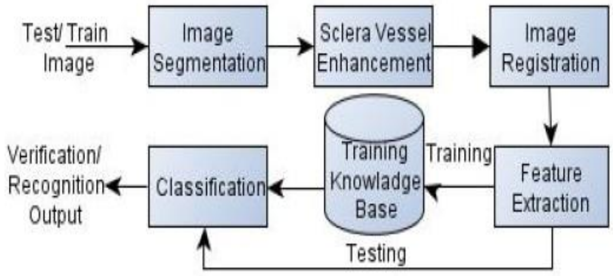

Fig2. Typical Sclera Biometric system

A. *Sclera Segmentation*

Segmentation is the first step for most biometric related research. Here the main aim is to identify the region of interest as appropriate as possible. Similarly in sclera biometric a perfect segmentation is important otherwise, an incorrect segmentation can reduce the pattern available, but also it can introduce other patterns such as eyelashes and eyelids. So in the literature of sclera biometric, the researchers have given a great importance to this phase.

Many binary skin-based segmentation algorithms have been developed to segment skin area on a human body depending on a different color space such as RGB, HSV, HIS and YCbCr [24, 25]. The performance of these methods have achieved satisfactory results in terms of accuracy
and complexity. However, these methods were tested only on limited databases with some having constrained imaging conditions. In addition, recent pixel-based sclera segmentation methods have used one color space which is not robust against noise factors and unconstrained imaging necessitating more post-processing complexity. As a result, sclera segmentation design depending on multiple color spaces will ensure the versatility of segmentation for constrained and unconstrained eye imaging but the complexity could be considerable.

Possibly [26] was the first work on automated sclera segmentation. Here, the sclera was segmented by a timeadaptive active contour-based method. The iris was localized in the detected eye strip in the binary image through template matching via an adaptive half-circle template.

A TASOM (Time Adaptive Self-Organizing Map)-based active contour method detailed in [27], [28] was used to get the inner boundary of the sclera.

In [29], the authors have designed enhancement and registration methods to process and match conjunctival vasculature obtained under non-ideal conditions.

In [30], a colour image sclera segmentation process was proposed, which includes image down sampling, conversion to the HSV colour space, estimation of the sclera region, iris and eyelid detection, eyelid and iris boundary refinement, mask creation, and mask up-sampling. In [31], a robust multi-angled sclera recognition technique was proposed. A new robust method of sclera segmentation for colour images was proposed in [32].

B. Sclera vessel enhancement and Image registration

The vessels in the sclera are not prominent, so in order to make them clearly visible, image enhancement is required. Various techniques for sclera vessel enhancement are found in literature. The first recognized work on sclera vessels enhancement is recorded in [33]. In [29] for image registration a local affine and a global smooth transformation was applied. A image mapping method was used in [34] to make the images invariant to rotation. In [35] and [30] sclera vain pattern enhancement by Gabor filter. In [36] selective enhancement filter for lines, and implicitly for blood vessels, as described in [37] and used in [38] was applied to the green component.

C. Feature extraction

The feature extraction of sclera recognition system involves in building a reliable mathematical model of the abstract sclera pattern to reliably identify persons for authentication and identification purposes.

In [39] the Discrete Cosine Transform and wavelets were used for feature representation. [40] GLCM (Grey Level Cooccurrence Matrix) was used for sclera biometrics. The authors in [31] presented four fusion methods for combining recognition results from multi-angle images. LBP (Local Binary Pattern) feature was used for sclera biometrics in [41]. A tile-based feature extraction method was used for sclera biometrics in [34].

D. Classification

Biometric algorithms generally aim to provide a reasonable answer for all possible inputs so classification plays a important role, its importance is also reflected in sclera literature. In [33] classification was performed by template matching against the stored template for verification by one-to-one matching was used.

For classification, template matching was used in [31]. In [32], [35] for classification, the Hamming distance was used for template-based matching. In [31] after feature extraction and matching technique SURF (Speeded Up Robust Features) was used for key point matching.

A feed forward Neural Network with a single hidden layer was used here for classification in [39]. In [40] match score level fusion of Fisher LDA and neural networks are used which provides the best results in classification.

III. Discussion

The literature relevant to sclera biometrics is not large, but is growing rapidly and spreads across a wide variety of sources. This survey suggests a structure for the sclera biometrics literature and summarizes the current state-of-theart. There are still a number of active research topics within Sclera biometrics. Many of these are related to the desire to make sclera recognition practical in less-controlled conditions and also a real time process as much as possible.

Limitations and challenges remain. These are: 1) sclera segmentation has not been investigated using heavily noise eye images; 2) Research in eye rotation alignment method is still missing which could affect the blood vessel angles and position matching; 3) sclera recognition has not been extensively investigated when eye images are captured on-the-move and at-a-distance.

IV. Conclusion

In this paper we studied the existing sclera segmentations methods which are use for different purposes, Biometric trait is one of the major applications for the sclera segmentation. The existing systems and their disadvantages are shown in section 2 and 3. In future the sclera methods can be enhanced by using eye gaze detection technique.

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