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Security System based on Sclera recognition

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Abstract- In this paper we delineate the new human identification method is proposed: sclera recognition technique. Due to the uniqueness of the sclera pattern, it can be used as identification in place of code, fingerprint, face recognition and voice recognition. To distinguish different patterns, some tonal and illumination corrections are performed to get a clear sclera area without disturbing the vessel pattern structure. This paper aims at developing a new method for sclera segmentation which works for both color as well as grayscale images. The blood vessel structure of sclera is different for different people and it lies in the region of the visible wavelengths, therefore it can be used for the human identification method (ID). To obtain shape and structure of a sclera vessel kernel functions are used in order to separate out the magnitude and phase plots. Gabor wavelet filter is a bi-dimensional Gaussian function which separates the R & G plane of the scanned image and due to its 2D nature, the B plane is difficult to plot as well as recognize (mathworks).

Key Words: **Biometrics, Sclera recognition, Sclera segmentation, Gabor function.**

1. INTRODUCTION:

Biometrics is the use of physical, biological, and behavioral traits to identify and verify a person's identity automatically. Researchers have devised various methods for human identification like facial recognition, iris recognition, voice recognition, fingerprint recognition, gait recognition, etc. But each and every recognition method has certain snags which increases the probability of exposing the identity of the individual. In this paper, we have proposed a new method for human identification which is Sclera recognition. Sclera recognition involves identifying the individual based on the positioning of blood vessels on the Sclera which is the outer protective covering of the eye.

In addition, in real- life applications, some biometrics may be more applicable than others in certain scenarios. For example, in general, the accuracy of iris or fingerprint recognition is higher than facial recognition. However, in a video surveillance application, facial recognition may be more preferable since it can be integrated into the existing surveillance systems. Sclera recognition can achieve comparable recognition accuracy to iris recognition in the visible wavelengths. Sclera blood veins have been investigated recently as a biometric trait which can be used in a recognition system. Sclera is the white and opaque outer protective part of the eye. This part of the eye has visible blood veins which are randomly distributed. Sclera vein patterns do not change with age and are not affected by consumption of alcohol. This feature makes blood veins a promising factor for eye recognition.

Fig 1. Shows the sclera region along with the structure of the eye.

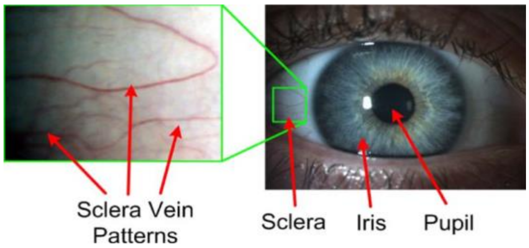

Fig 1. Structures of the eye and sclera region.

TABLE I : MAIN BIOMETRIC PROPERTIES

	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.

2. LITERATURE SURVEY

Sclera is the white opaque outer protective covering of the eye. Sclera consists of many blood vessels which differ in thickness. Some are clearly visible while some are note that clearly visible. Thus, the patterns of blood vessels on the sclera contain various variations. The positioning of blood vessels on the sclera is unique for every individual thus making this identification method i.e Sclera recognition a reliable one. Sclera recognition is the identification of an individual based on the positioning of blood vessels on the sclera of that person.

3. IMPLEMENTATION

The sclera recognition system is composed of four modules- Sclera Segmentation, sclera vessel feature extraction, sclera vessel feature matching and matching decision.

First, an input image in taken from the system. During preprocessing we convert our input colored image to grayscale as we decode the whole thing in terms of binary.

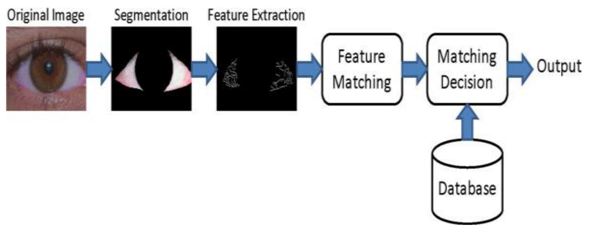

Fig. 4. Proposed sclera recognition system.

3.1 SCLERA SEGMENTATION

The first part in sclera recognition is sclera segmentation. In segmentation, we retain the sclera part and get rid of the other useless parts of the input image. This is done using the following steps:

3.1.1 Grayscale conversion

The input image is first converted to grayscale image. This can be easily done using the equation:

X=0.30R+0.59G+0.11B

This equation converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance.

3.1.2 Image segmentation

The image is segmented after it has been converted to grayscale. In segmentation, the image is divided into different parts so as to obtain the required features. We have done the image segmentation by considering the median value of the pixels.

3.1.3 Intensity enhancement

Once the image has been segmented, its intensity has to be enhanced so that the blood vessels become more visible and thus easy to detect and extract. We used the adaptive histogram equalization for enhancing intensity.

3.1.4 Complementing the image

In the complement of a binary image, zeros become ones and ones become zeros; black and white are reversed. In the complement of an intensity or RGB image, each pixel value is subtracted from the maximum pixel value supported by the class and the difference is used as the pixel value in the output image. This is done in order to extract the blood vessels in the sclera region more effectively and make them look sharper.

3.1.5 Applying Gabor Filter

Gabor filter is a linear filter used for texture analysis, which means that it basically analyses whether there are any specific frequency content in the image in specific directions in a localized region around the point or region of analysis. Gabor filter is applied in order to highlight the sclera area better which is required to extract the features efficiently. Formula for Gabor filter is:

$$G_c[i,j] = Be^{-\frac{(i^2+j^2)}{2\sigma^2}} \cos(2\pi f(i\cos\theta + j\sin\theta))$$
$$G_s[i,j] = Ce^{-\frac{(i^2+j^2)}{2\sigma^2}} \sin(2\pi f(i\cos\theta + j\sin\theta))$$

3.1.6 Applying Gaussian filter

During Gaussian filtering each individual pixel is replaced with a Gaussian shaped blob with the same total weight as the original intensity value. This Gaussian is also called the convolution kernel. It renders small structures invisible, and smoothens sharp edges. This filter is used for removing the noise generated in the Gabor filtered image.
The formula for Gaussian filter is:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

3.1.7 Applying the median filter

The median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the *mean* of neighboring pixel values, it replaces it with the *median* of those values. This filter is applied to reduce the blurring effect and make the image look clearer to extract the features.

3.2 Feature Extraction

In this part, we extract the blood vessels from the image for matching purposes. We have used the Speeded Up Robust Features (SURF) algorithm to detect the features in the image. The algorithm has three main parts: interest point detection, local neighborhood description and matching. The following formula is used for detection of SURF features:

$$H(p,\sigma) = \begin{pmatrix} L_{xx}(p,\sigma) & L_{xy}(p,\sigma) \\ L_{yx}(p,\sigma) & L_{yy}(p,\sigma) \end{pmatrix}$$

3.3 Feature Matching

Various image matching algorithms are developed and being used for the purpose of matching images. After the feature extraction process, the registration of individual templates is done. After that, each line segment in the test template is compared with the segment from the registered template, to check if the match is found. Each segment descriptor has an individual match score that is found. If the matching score ("S(Li, Lj)") is non-zero then the segments are removed and further processing is done on it and final matching score for that segment is noted down.

Here, S(Li, Lj) is the matching score for a particular segment.

3.4 Matching Decision

The final matching decision is to be taken on the basis of matching score and acceptance rates. The performance of the system is evaluated using three parameters: False Acceptance Rate (FAR), False Reject Rate (FRR) and Genuine Acceptance Rate (GAR).

False Accept Rate (FAR), False Reject Rate (FRR) and Genuine Acceptance Rate (GAR).

FAR is calculated as [FP⁄(TN + FP)]*100 %
FRR is calculated as [FN⁄(TP + FN)]*100 %
And GAR is calculated as 1-FRR %

Where,

FP is the False Positive i.e. incorrectly rejected.
TP is the True Positive i.e. correctly identified.
TN is the True Negative i.e. correctly rejected.
FN is the False Negative i.e. incorrectly rejected.

CONCLUSION

This paper presents a new biometric approach of sclera recognition. Thus, a new option for human ID is provided. Multiple recognition methods such as voice recognition, face recognition, iris recognition, gait recognition, etc. are present. These identification methods have some drawbacks which are overcome by sclera recognition. This is a very challenging research for human identification as the matching speed of sclera recognition is quite slow which might impact its real time applications.

FUTURE SCOPE

Sclera recognition can be combined with other biometrics such as iris recognition to perform multimodal biometrics. Currently, the proposed system has been implemented in Matlab. Currently, this method of authentication is under development. Multiple techniques can be developed and used for achieving more accuracy in this biometric recognition. The processing speed can be greatly reduced by parallel computing approaches.

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