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Survey Paper on Human Identification Using Sclera

[1] Vanita Patil, [2] Dr. A M. Patil

[1] Dept of E&TC,
J T Mahajan College of Engineering.
Faizpur. Maharashtra.

[2] Dept of E&TC,
J T Mahajan College of Engineering.
Faizpur. Maharashtra.

Abstract - The structure of blood vessels in the sclera- the white part of the human eye, is unique for every individual, hence it is best suited for human identification. However, this is a challenging research because it has a high insult rate (the number of occasions the valid user is rejected). In this survey firstly a brief introduction is presented about the sclera based biometric authentication. In addition, a literature survey is presented. We have proposed simplified method for sclera segmentation, a new method for sclera pattern enhancement based on histogram equalization and line descriptor based feature extraction and pattern matching with the help of matching score between the two segment descriptors. We attempt to increase the awareness about this topic, as much of the research is not done in this area.

Keywords - *Sclera Recognition, Histogram Equalization, Image Processing, Line Descriptor, Sclera Segmentation.*

1. Introduction

From the combat zone to the cooperate office, from the airport to the ATMs, knowing really who is who, is the big security concern. Traditionally, a person might enter a password or provide a driver's license or a passport as a proof of identity. The authentication of any individual is mandatory in many different areas in our day to day life, with people having to authenticate themselves on daily basis. Every person carries multiple human traits that are unique form of personal identification. The primary advantage of biometric trait is that it belongs to an individual unlike passports or other such documents. What is biometrics? It is the process of identifying and verifying people based upon their unique behavioral and physical patterns. Biometrics can be divided into two broad parts: the physical biometrics and behavioral biometrics. In turn physical biometric again divided in to Iris, Sclera, Hand recognition, Fingerprint, Face recognition. Whereas behavioral divided in to signature and keystone. Biometrics based on physical behavior plays an important role, which includes the geometrics of the hand, the ridges of the finger prints, patterns in an iris, the structure of the face, the voice and sclera vein patterns. All of these have their pros and cons. Iris recognition system processes the full iris, so when the eye's gaze is off-center only a portion of the iris is seen and the recognition is hindered. And thus sclera was additionally proposed as the basis of identification. Sclera is the white protective covering of an eye, which surrounds an iris. The biometric using sclera is the most important and effective biometrics, because the veins in the sclera of an individual do not change with the age, redness and alcohol consumption.

However, a lot more work is left for the researchers to do in the field of sclera based biometrics. Sclera based recognition is a challenging issue because eye being the moving structure the sclera vein patterns move and get deformed i.e. contract or dilate. Also, sclera is reflective which makes its probable for going out-of-focus. The multiple layers in the sclera patterns results into a complicated non-linear pattern deformation, when eye or surrounding tissue moves. We hope our survey serve the need for the future research.[6][7][15]

2. Literature Survey

The pattern of veins in the sclera of a human eye consists of several variations but they are unique for every individual. In this paper we have presented a simplified and novel approach to sclera biometrics. The job is divided into several parts:

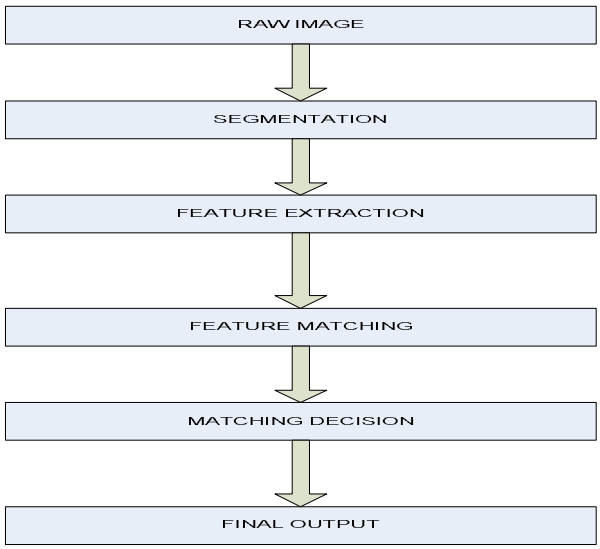

Figure 1. Flowchart of the proposed method.

2.1. Input Raw Image

It is observed that most of the insult rates are due to poor quality of input images, therefore better camera resolution is a very important initial requirement for sclera based biometrics. Moreover, the iris should be in the middle of the eye with proper orientation, so that common algorithm can be used for further processing. The mentioned problem can be resolved using sclera ROI registration which is global standard for achieving proper orientation, translation and scaling.

2.2. Segmentation

Locating and isolating sclera area.
This work is divided into following steps:
The input RGB image is first converted to gray scale by calculating 8-bit gray value.

This can be easily done using MATLAB
inbuilt method:new_img=rgb2gray("RGB_image")

2.2.1. Applying Horizontal Sobel FilterSobel edge detection method is used to highlight high magnitude edges in the image. MATLAB functionBW=edge(Img,'sobel') isa inbuilt function for edge detection using sobel.

Where,BW is resultant binarized image. Img is input image.sobel is keyword which specifies sobel method.

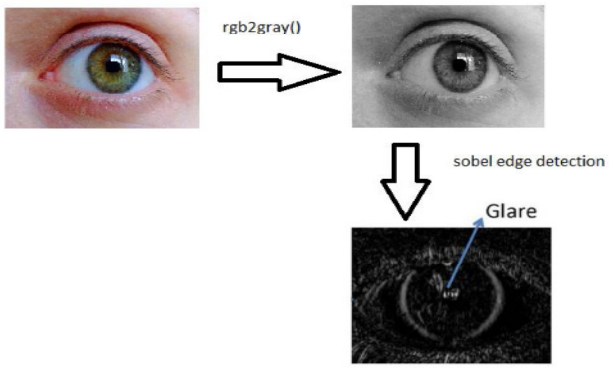

Figure 2. Grayscale conversion, applying sobel filter.

2.2.2. Iris Boundary Detection

To detect the boundary of iris we use greedy angular search algorithm [4] on image after edge detection is done. This algorithm searches in radial direction using predefined angles to detect iris boundaries.

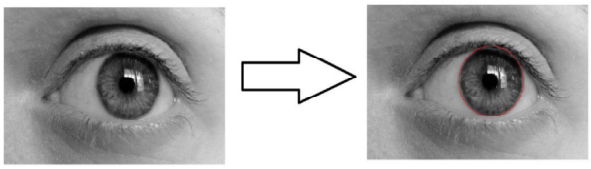

Figure 3. Image after applying greedy angular search algorithm.

2.2.3. Detecting Sclera Area and Pattern Enhancement

Sclera area can be easily detected from grayscale image using Otus's method. Otus's [5] method assumes image to be made of two classes, foreground and background, depending on the intensity. Thresholding is used to achieve this. For contrast enhancement of the detected pattern, we use histogram equalization. The MATLAB function used for enhancement is: histeq().

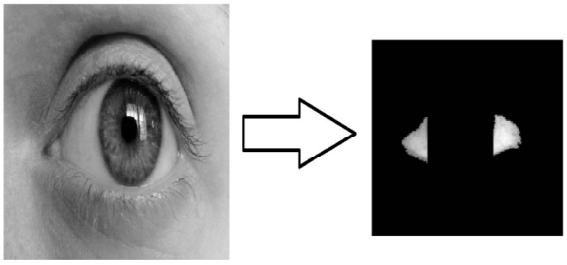

Figure 4.Thresholding and histogram equalization.

2.3. Feature Extraction

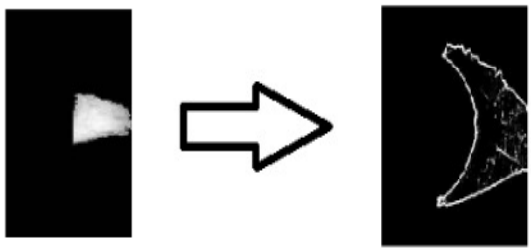

Figure5. Adaptive thresholding for featureextraction.

Sclera feature extraction is extraction of blood vessel pattern in the form of template of several line segments. Firstly, asmentioned above with the help of histogram equalization the veins in the sclera are enhanced and then with the help of adaptive thresholding technique these line segments' are binarized. However, these binary-pixel lines are not suitable for recognition because the vessel thickness can change due to various external features like fatigue, non-fatigue, etc. Hence they are thinned to single-pixel wide lines which are obtained by several binary morphological operations that are used to thin the detected lines. These lines are then resolved recursively into smaller segments. We will keep on doing this till we get line segments which are nearly linear. In this, the size of each line is five pixels. Using these line segments we create template for vein structure. Three quantities are required to describe each segment:

1. Segment's angle to a particular reference angle at the pupil center.
2. Segment's distance to the pupil center.
3. Angular orientation of the line segment

A descriptor is R = ((α s β) ^ T).
The individual components of the line descriptor are calculated as:

$$\alpha = \tan{-1}(yl - yi / xl - xi)$$
$$s = \sqrt{((yl - yi)^2 + (xl - xi)^2)}$$
$$\text{And } \beta = \tan{-1}(d/dx(fm (x)))$$

Where fm = polynomial approximation of the line segment.
(x1, y1) is the center point of the line segment.
(xi, yi) is the center of the detected iris.

R is the line descriptorSet of all the individual line descriptors' result into the template for the sclera vessel structure.

2.4. Feature Matching Using Database

Firstly, matching (image processing) algorithms are designed and used for matching purpose. These algorithms' should be tolerant to segmentation errors. Each individual templates are registered after acquiring them through feature extraction processes. 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. Initially, an individual match score for each segment descriptor 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.Li and Lj are the two segments one from the test template and the other from the target template. After this is done the final matching score is to be found for the entire template. This can be done by adding the individual matching scores of each segment descriptor and then dividing it by the maximum of the minimal sets between the test and registered template. [16].

2.5. Matching Decision

After the above processes are performed, a final matching decision is to be taken on the basis of matching score and acceptance rates. The receiver operating characteristic (ROC) is used to evaluate the performance of the system, which can be done using three parameters: 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. [3].

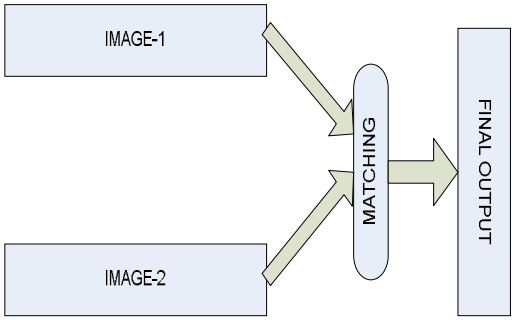

Figure 6.Block Diagram of decision making.

3. Discussion & Conclusion

This paper presents a new biometric approach of sclera recognition. Here the image from the database is compared with the image for which authentication is to be done. A sclera segmentation method is presented and then the enhancement of the sclera vein patterns is performed. Later, with the matching algorithm the comparison of the patterns of the veins in the sclera is done and authentication is performed. This is a very challenging research for human identification. It has several advantages over iris based recognition. A future step is to overcome the challenges in acquiring the image and combing sclera recognition with iris recognition. Also the template's aging effect ought to be studied.

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Ms. Vanita Patil had completed her BE in E&TC and pursuing M.E. from the J.T. Mahajan college of Enginerering Faizpur. Maharashtra.

Prof. Dr. A. M. Patil, PHd in electronics from North Maharashtra University. And working as a Professor in Dept of E&TC .in J.T.Mahajan College of Engineering, Faizpur. Maharashtra.