

Integrated Approach for Sclera Recognition and Eye Gaze Detection

Snehal S. Rajole, Prof. J. V. Shinde

Department of Computer Engineering, Late G.N. Sapkal COE, Nashik, Savitribai Phule Pune University, Pune, Maharashtra, India

Abstract—

In this paper we proposed unique technique which is adaptive to noisy images for eye gaze detection as processing noisy sclera images captured at-a-distance and on-the-move has not been extensively investigated. Sclera blood vessels have been investigated recently as an efficient biometric trait. Capturing part of the eye with a normal camera using visible-wavelength images rather than near infrared images has provoked research interest. This technique involves sclera template rotation alignment and a distance scaling method to minimize the error rates when noisy eye images are captured at-a-distance and on-the move. The proposed system is tested and results are generated by extensive simulation in java.

Keywords— Biometrics, feature extraction, Gabor filter's, kernel, linear discriminates analysis, pattern recognition, sclera recognition

I. INTRODUCTION

Sclera segmentation gain substantial importance for eye & iris biometrics. sclera segmentation has not been extensively researched as a separate topic, mainly summarized as a component of a broader task[1]. The sclera is the white and opaque areas of blood vessels and connective tissue within the eye. This part of the eye surrounds the iris which is the colored tissue around the pupil [2]. The sclera as shown in Fig. 1, has a rich pattern of blood vessels which have different orientations and layers. Therefore, the discriminant characteristics of these blood vessels are thought a bright factor for eye recognition under visible wavelength illumination [3]. Sclera recognition has received attention recently due to the distinctive features extracted from blood vessels within the sclera. However, errant human pose, multiple iris gaze directions, completely different eye image capturing distance and variation in lighting conditions cause several challenges in sclera recognition. The various challenges in sclera recognition comprises of exact segmentation of the sclera area, sclera vessel enhancement & the extraction of judicial features of the sclera vessel pattern for authentication & recognition purposes. The task becomes harder as often a complete sclera image is not received but is impeded by portions of the eyelid & eyelashes.

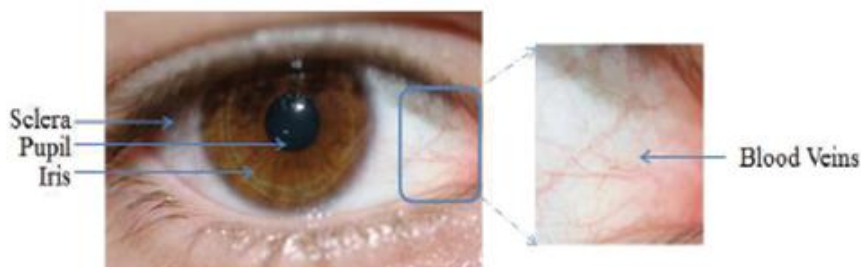


Fig. 1. Eye structure it consisting of pupil, iris and sclera region

Moreover, different lighting conditions can change the appearance of the texture patterns by accentuating & attenuating various grey tones. After that, a classification system uses the mathematical model of the sclera texture to compare with other sclera images to identify specific individuals or recognize an individual. In this paper we proposed eye gaze detection technique which will enhance the sclera recognition when the images are captures on or at the move. Our contribution includes a fusion method for sclera segmentation which is adapted to noise factors; An efficient sclera template rotation alignment method which is invariant to eye rotation and A robust sclera scaling method to minimize the effect of sclera image capturing on the- move and at-a-distance.

II. EXISTING WORK

In existing system First for the iris segmentation, we used the integro- differential operator to locate the circular pupil and iris regions . Specular reflection removal is applied to remove the brightest points in the iris image. Then, for each image, iris center coordinates $C_{iris}(x; y)$ and radius r are stored. We propose a new fusion method for segmenting sclera regions which is adaptive to noise factors. This method creates two binary maps for the eye image and fuses them to enhance the sclera area detection for noisy images.

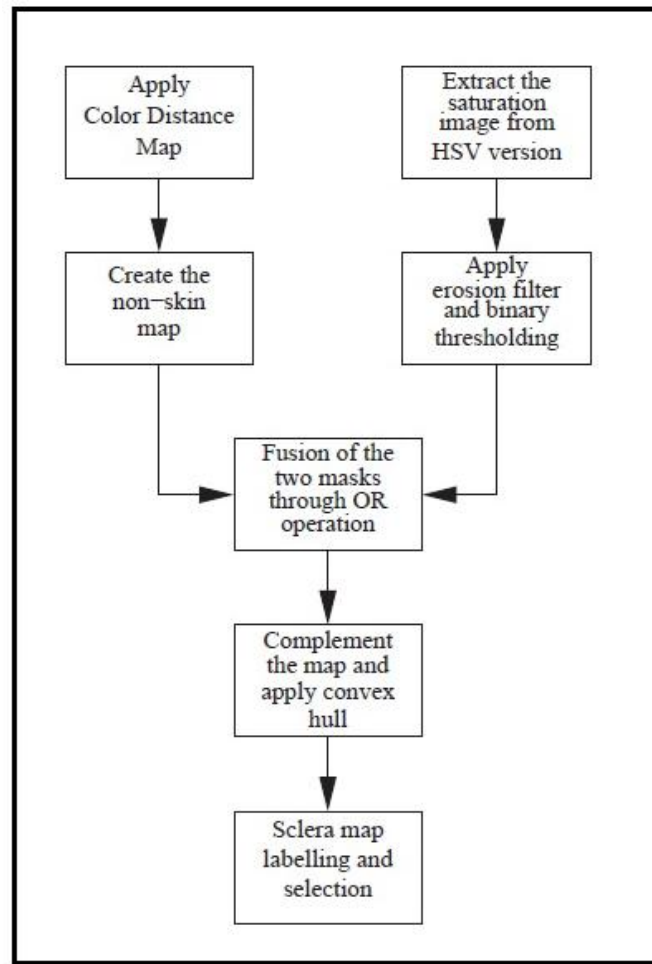


Fig. 2. sclera segmentation algorithm

After this we will refer to the Image Rotation Alignment and Distance Scaling method as (IRADS). First, the rotation alignment process for (F G) which is depicted in Fig. 3 is achieved as follows

- 1) divide each individual mask into two sections around the detected iris and extract the four internal corners c_1 , c_2 , c_3 and c_4 of the sclera binary mask using Harris corner detection
- 2) calculate the internal angles of these corners ϕ_1 ; ϕ_2 ; ϕ_3 and ϕ_4 with respect to y-axis of the iris center position;
- 3) adjust the angles ϕ_1 ; ϕ_2 ; ϕ_3 and ϕ_4 to be equal to 45 by applying an image rotation function which uses nearest neighbour interpolation to rotate an image with a specified angle L;

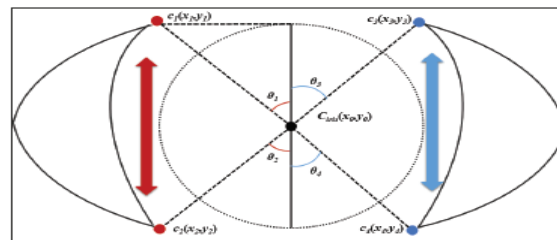


Fig. 3. Sclera rotation alignment where internal sclera corners c_1 , c_2 , c_3 and c_4 are detected and ϕ_1 ; ϕ_2 ; ϕ_3 and ϕ_4 are calculated.

Next step is sclera blood vessels enhancement. To enhance the segregation of the sclera blood veins from their background, two steps are utilized which include extracting the green channel of the sclera image and applying Contrast-Limited Adaptive Histogram Equalization (CLAHE) which enhances the local contrast of blood vessels. Then we analyse the sclera image features by using a bank of Gabor filters. After this KFDA is use for feature extraction. The KFDA method maps the feature sets by a nonlinear mapping Φ into some feature space F and applies Fishers linear discriminant with a Mercer kernel strategy . This strategy formulates the algorithm using a dot products $(\Phi(x) , \Phi(y))$ to overcome the limitation of the inability to solve between and within class scatter matrices directly if F is very high or has infinite dimension space. And at last the Mahalanobis cosine similarity distance is used for similarity distance. After this the Gaze detection is done and matching process will be carried out. After this the Gaze detection is done and matching process will be carried out.

III. PROPOSED SYSTEM

A fusion method for segmenting sclera regions which is adaptive to noise factors. This method creates two binary maps for the eye image and fuses them to enhance the sclera area detection for noisy images. The novel contributions to mitigate as the above limitations on a sclera recognition system is proposed:

- 1) A fusion method for sclera segmentation which is adapted to noise factors.
- 2) To build efficient sclera template rotation alignment method which is invariant to eye rotation.
- 3) A Robust sclera scaling method to minimize the effect of sclera image capturing on-the-move and at-a- distance.

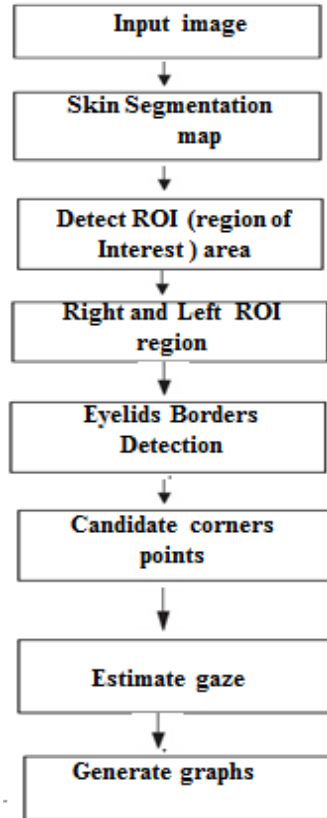


Fig.4 Architecture diagram

A. Algorithm

The algorithm is as follow:

Step 1 :

Classify each pixel into skin or not-skin labels using the Color Distance Map (CDM) First, two skin clusters for natural illumination and ash illumination conditions are extracted which are defined as

$$CDM_1 = \begin{cases} 1, & R > 95, G > 40, B > 20, \\ & \max(R, G, B) - \min(R, G, B) > 15, \\ & |R - G| > 15, R > G, R > B \\ 0, & \text{otherwise} \end{cases},$$

$$CDM_2 = \begin{cases} 1, & R > 220, G > 210, B > 170, \\ & |R - G| \leq 15, B < R, B > G. \\ 0, & \text{otherwise} \end{cases}$$

Then, the non-skin map is created based on these clusters as

$$S_1 = \begin{cases} 1, & \text{if } CDM_1 \parallel CDM_2 = 0 \\ 0, & \text{otherwise} \end{cases},$$

Step 2 :

The second sclera map is generated by converting the eye image from RGB color space into the HSV color space and extract the saturation level as the sclera region has a low saturation value. Then, we used an erosion filter where the saturation image is probed with structure element having a disk shape with size of 55 in order to erode the white pixels within the sclera. After that, the second binary map S2 is generated by thresholding the littered image I(x, y) as

$$S_2 = \begin{cases} 1, & \text{if } I(x, y) > th_i \\ 0, & \text{otherwise} \end{cases},$$

Step 3:

Template rotation and alignment

a. Rotate the image using IRADS

$$\tau = \begin{cases} (\phi_2 - \phi_1), & \text{if } \phi_1 > \phi_2 \\ (\phi_1 - \phi_2), & \text{if } \phi_1 < \phi_2, \\ 0, & \text{otherwise} \end{cases}$$

b. Detect the corner using haris corner detection

c. Minimize distance e_ect an sclera template

d. Extracted areas are resized

Step 4:

a. Extract green channel

b. Apply CLAHE which will enhances local contrast of blood vessels as in below equation

$$G_{u,v}(x, y) = I(x, y) * \psi_{u,v}(x, y),$$

c. Analyze S.I feature by using bank of Gabor filter

Step 5:

a. KFDA: map the features sets by applying fishers linear discriminant with a Mercer kernel

$$J(\alpha) = \arg \max_{\alpha} \frac{\alpha^T K_B \alpha}{\alpha^T K_W \alpha},$$

b. Mahalanobis Cosine similarity distance (-1 to 1) value

B. Data set UBIRIS.v2 (Base paper)Description:

We utilized the UBIRIS.v2 database to evaluate the performance of our proposed method. This database was captured in non constrained conditions (on-the-move, at-a distance with more realistic noise factors) with two sessions; where session 2 has a different location, luminosity and acquisition device to increase heterogeneity with 261 participating subjects capturing both eyes resulting in 522 sclera images.



Fig. 5: UBIRIS.v2 eye image examples captured at different distances. The upper row images were captured at 4m, the middle row images at 5m while the lower row images at 6m.

C. Data set (real time):

We utilized the real time capture database to evaluate the performance of our proposed method. This database was captured in non-constrained conditions (on-the-move, at-a distance with more realistic noise factors)



Fig.6 Real time Eye images examples captured images

D. Evaluation parameter:

1. Detection rate and Time :

Effect of image processing on nodule detection rates in digitized chest radiographs:ROC study of observer performance biometric security system algorithm used to all ready determine the threshold value for its false acceptance rate and its false rejection rate when rates are equal ,if the value is common then the value is referred as the equal error rate.

$$gaze = 2 * (width / 5)$$

IV. EXPERIMENTAL RESULTS

A. Results:

To test the performance of the proposed system we have implemented the system in java with window operating system. Initially we give normal eye image captured as a input to the system as shown in fig 7.



Fig. 7. Input Image

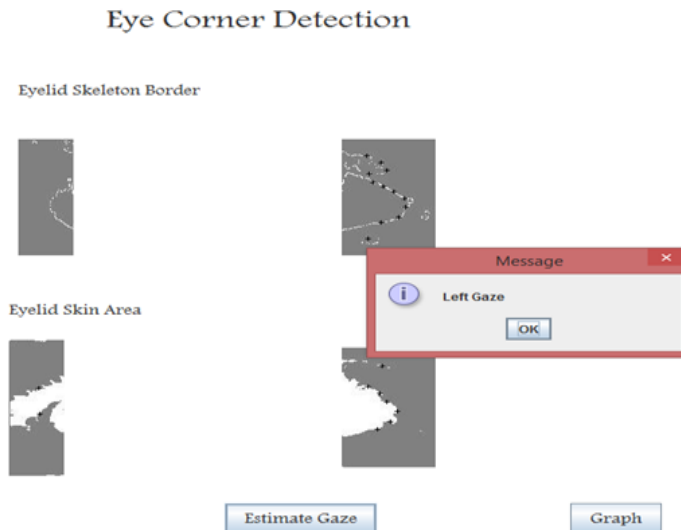


Fig. 8. Eye corner detection output image

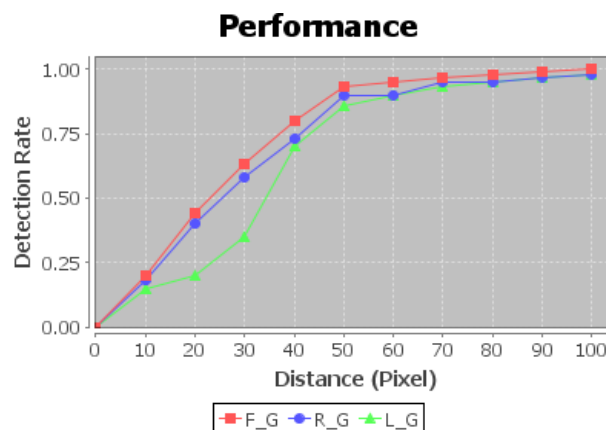


Fig. 9. Eye corner detection graph

V. CONCLUSIONS

In this paper we proposed a novel approach for Eye gaze detection. our proposed work is adaptive to the noisy images and also for the image which are capture on the move and at a distance. The proposed architecture includes robust sclera scaling method to minimize the effect of sclera image capturing on-the-move and at-a-distance. The performance of the system is calculated by testing the system on multiple images and result generated are showed in Result section.

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ABOUT AUTHOR

Ms. Snehal S. Rajole completed her graduation from K.V.N. Naik college of Engineering Nashik, Maharashtra presently she is perusing her post-graduation from L.G.N. Sapkal college of Engineering Nashik, Maharashtra India. Her research of interest include image processing, Sclera segmentation, Sclera recognition, pattern recognition.

Prof. Jayshree V. Shined presently she is working at KCT's Late. G. N. Sapkal College of Engineering, Nashik, Maharashtra, India as a Assistant Professor. She has presented papers at national and international conference as well in journals on various aspects of the computer engineering. Her research of interest includes image processing.