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# Human Identification Based on the Histogram of Oriented Gradients

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***Abstract*— This paper proposes a new human identification based on the pattern of blood vessels seen in the sclera region of human eye. Blood vessel structure seen in the sclera region is unique to each person. To make the identification more accurately, a new method of feature extraction is incorporated which is Histogram of Oriented Gradients (HOG). By using this method, the different orientation of blood vessels in the sclera region is obtained which make it easier for sclera recognition. Software WEKA, which is machine learning used to measure the percentage of similarity measure between the training set and testing set of images. These experiments are done with the help of UBIRIS database. The experimental result shows that sclera recognition can achieve high accuracy in visible wavelength.**

***Keywords—Human identification, Sclera recognition, Otsu's thresholding, Histogram of Oriented Gradients(HOG), WEKA***

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## I. INTRODUCTION

Automatic recognition of a human being based on some unique feature is an important task. Nowadays, identification is possible with the password, Personal Identification Number (PIN), ID card, key etc... But these technologies have a common problem to differentiate an individual. To reduce the security issues, biometric systems is used. Biometric system is a pattern recognition system which operates by getting biometric information from an individual and extracting feature from it and compare with the images in the database. Some of the important biometrics used for the identification purpose is fingerprint, face, voice, gait, retina, iris etc... Each biometric has its own advantage and disadvantage. Sclera recognition is one of the new emerging biometric technologies for the identification. Sclera is the white portion of the human eye which is fibrous, opaque and act as a protective covering containing collagen and elastic fiber. The blood vessel structures seen in the sclera region have a unique pattern, from eye to eye and from person to person. So sclera recognition is called as the promising biometric for the identification purpose. Fig.1 shows the image of human eye and its corresponding vein pattern [1]. Iris recognition is also a new technology for identification. But there is a drawback of iris images is that its recognition accuracy is very poor in visible wavelength. So it needs additional NIR illuminators. This gives sclera recognition as a new art to iris recognition [2].

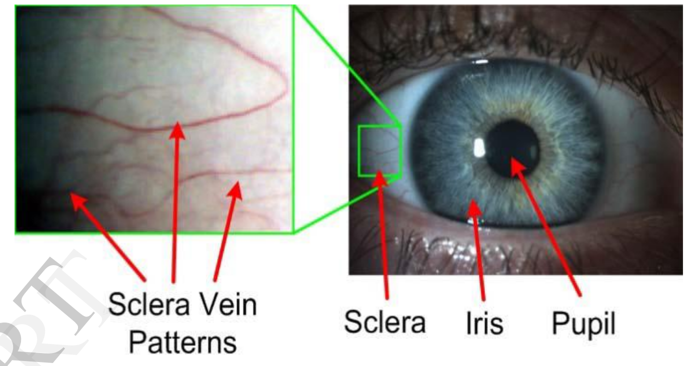


Fig. 1 Sclera region and its vein pattern

Sclera recognition system consists of four parts: sclera segmentation, vein pattern enhancement, feature extraction and identification which is shown in Fig. 2 Here proposed a new method of feature extraction called Histogram of oriented gradients (HOG). It gives the directional change of orientation information of the detected vein pattern from sclera region [3]. For the identification purpose, a new software is introduced which is WEKA. It stands for Waikato Environment for Knowledge Analysis. WEKA supports many data mining tasks such as data pre-processing, classification, clustering, regression and feature selection. Here WEKA is used for identification.

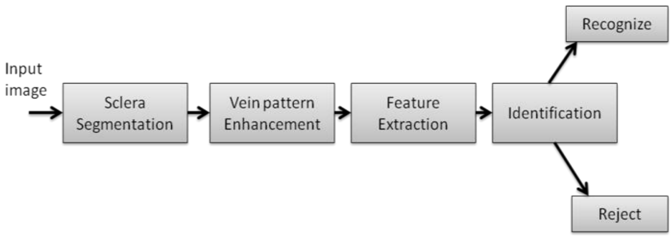


Fig. 2 Sclera Recognition System



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## II. SEGMENTATION OF SCLERA

Segmentation of sclera region is the first step for recognition. It includes three steps: glare area detection, sclera area estimation and iris and eyelid detection and refinement.

### *A. Glare area detection*

Glare area is a small bright area in the pupil or iris. This is an unwanted portion in the image. Sobel filter is used to detect the glare area. But it works only in the gray-scale image. If the image is color, then it needs conversion to gray-scale image and after that apply it to the sobel filter to get the desired result. Fig. 3 shows the result of glare area detection.

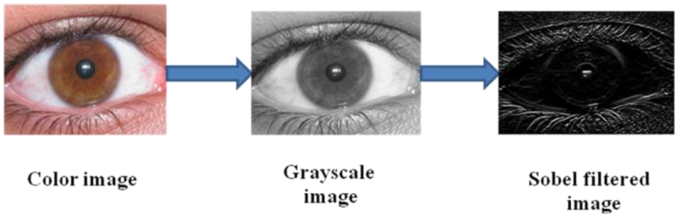


Fig.3 Detection of Glare Area

### *B. Sclera Area Estimation*

For the estimation of sclera area, Otsu's thresholding method is used. Fig. 3 shows the steps of Otsu's method: selection of the region of interest (ROI), Otsu's thresholding, sclera area detection. Similarly, the left sclera area is segmented [1].

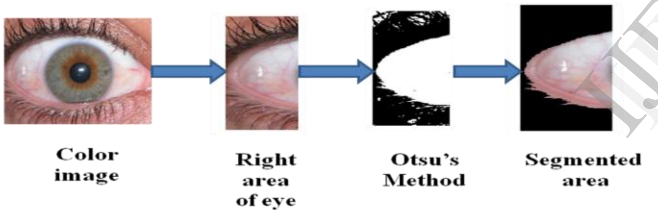


Fig. 4 Sclera Area Estimation

## III. VEIN PATTERN ENHANCEMENT

Normally, sclera region is more reflective. So there is some difficulty to see the vein pattern in the sclera region. To reduce these illumination effects and make it as an illumination invariant system, it is important to enhance the vein pattern. Gabor filters are used to the enhance vein pattern in the sclera. Due to the multiple orientations in the vein pattern bank of Gabor filter is used for vein pattern enhancement.

$$G(x,y,\upsilon,s) = e^{-\pi\left(\frac{(x-x_o)^2+(y-y_o)^2}{s^2}\right)} e^{-2\pi i(\cos\upsilon(x-x_o)+\sin\upsilon(y-y_o))}$$

(1)

Where, $(x_0, y_0)$ is the center frequency of the filter, 's' is the variance of the Gaussian and 'υ' is the angle of sinusoidal modulation. The image is filtered with the Gabor filter, and then the output will be the enhanced vein image in the sclera area.

$$I_F(x,y,\upsilon,s) = I(x,y) * G(x,y,\upsilon,s)$$
(2)

Where, I(x, y) is the segmented sclera image, G(x, y, υ, s) is the Gabor filter and $I_F$ (x, y, υ, s) is the Gabor filtered image.

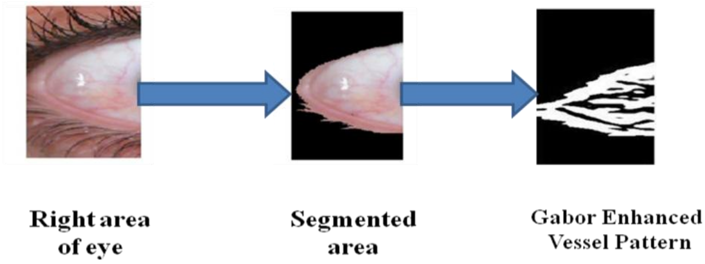


Fig. 5 Enhanced Vein Pattern

To binarize the Gabor filtered image, an adaptive thresholding method used. Vein pattern have different thickness at different times, this is because of dilation and constriction of vessels. Inorder to avoid this effect morphological operation is used. Morphological operations can thin the detected vessel structure and remove the branch points [1]. Fig. 6 shows the image after the morphological operations.

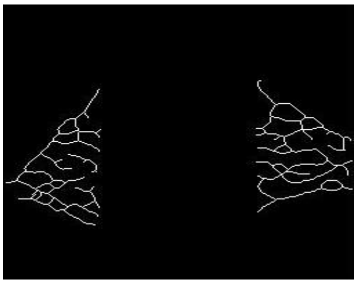

Fig. 6 After morphological operation

## IV. FEATURE EXTRACTION

Feature extraction is an important part of human identification. In the proposed system, a new method of feature extraction is used. The algorithm used for feature extraction is Histogram of Oriented Gradients (HOG).

Histogram of Oriented Gradient is a feature descriptor used for object detection. In the sclera region the vein patterns are the edges of an image. So, HOG is used to find the gradient orientation and edge orientations within an image. It decomposes the image into cells and compute histogram of gradient direction of the pixels within the cell. Then, combination of different histogram from different cell represents the descriptor. Main advantage of Histogram of Oriented Gradient is that it shows invariance to geometric and photometric changes [3].

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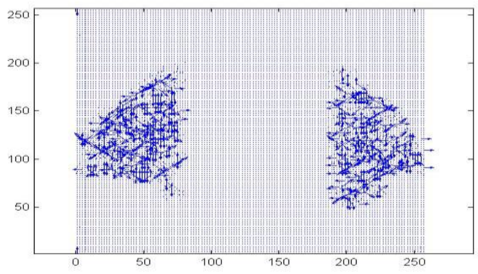


Fig. 7 Extraction of HOG Features

In this paper, HOG features of vein pattern in the sclera region are extracted from local regions. In Fig. 7 the edge orientation of each pixel is shown. At first, the edge gradients and orientation are calculated in this pixel region. Filter mask is used to obtain the edge gradient and orientation. The gradient magnitude m(x, y) and orientation $\theta$(x, y) are calculated using x and y directional gradients dx(x, y) and dy(x, y) [6].

$$m(x,y) = \sqrt{dx(x,y)^2 + dy(x,y)^2} \quad (3)$$

$$\theta(x,y) = tan^{-1}\left(\frac{dy(x,y)}{dx(x,y)}\right) \quad (4)$$

The local region of an image is divided into small regions called cells. Then, calculating the histogram of oriented gradient from each cell. The total number of HOG features from each cell concatenates to get the final feature vector.

## V. IDENTIFICATION

Extracted HOG features of the edges are taken into one file and trained and test using WEKA software. WEKA's functionality can be accessed through the graphical user interface. The most popular interface is the Explorer which allows quick exploration of data.

For training process, extracted HOG features from the images in the database are trained with the classifier in the WEKA. Fig. 8 shows the classification result of the trained data. The time taken to build the classification of different users is 0.02ms. By using the WEKA software the classification must be more accurate. Fig. 9 shows the confusion matrix of the classification of 7 users.

```
=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances          21              100      %
Incorrectly Classified Instances         0                0      %
Kappa statistic                          1
Mean absolute error                      0
Root mean squared error                  0
Relative absolute error                  0      %
Root relative squared error              0      %
Total Number of Instances               21

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0          1         1         1          1        user1
                 1         0          1         1         1          1        user2
                 1         0          1         1         1          1        user3
                 1         0          1         1         1          1        user4
                 1         0          1         1         1          1        user5
                 1         0          1         1         1          1        user6
                 1         0          1         1         1          1        user7
Weighted Avg.    1         0          1         1         1          1
```

Fig. 8 Training Set

```
=== Confusion Matrix ===

 a b c d e f g   <-- classified as
 3 0 0 0 0 0 0 | a = user1
 0 3 0 0 0 0 0 | b = user2
 0 0 3 0 0 0 0 | c = user3
 0 0 0 3 0 0 0 | d = user4
 0 0 0 0 3 0 0 | e = user5
 0 0 0 0 0 3 0 | f = user6
 0 0 0 0 0 0 3 | g = user7
```

Fig. 9 Confusion Matrix of Trained Set

For testing, this software can correctly identify the person using the trained data of the features. By using this method the identification will be more accurate. Fig. 10 shows the test data of a user and Fig.11 shows the confusion matrix of the test data. From the Fig. 10 and Fig. 11, user 5 is correctly identified.

```
=== Evaluation on test set ===
=== Summary ===

Correctly Classified Instances           1              100      %
Incorrectly Classified Instances         0                0      %
Kappa statistic                          1
Mean absolute error                      0
Root mean squared error                  0
Relative absolute error                  0      %
Root relative squared error              0      %
Total Number of Instances                1
```

Fig. 10 Test Set

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```
=== Confusion Matrix ===

 a b c d e f g   <-- classified as
 0 0 0 0 0 0 0 | a = user1
 0 0 0 0 0 0 0 | b = user2
 0 0 0 0 0 0 0 | c = user3
 0 0 0 0 0 0 0 | d = user4
 0 0 0 0 1 0 0 | e = user5
 0 0 0 0 0 0 0 | f = user6
 0 0 0 0 0 0 0 | g = user7
```

Fig. 11 Confusion Matrix of Test data

Histogram of Oriented Gradients based feature extraction and classification of training and testing are more accurate than the previous methods. The accuracy of testing the data is 100%. So, sclera recognition can achieve better result to identify a human being.

## VI. CONCLUSION

The new method of human identification based on the pattern of blood vessels of sclera is proposed. This method is completely based on the Histogram of Oriented Gradients (HOG) as feature vectors extracted from the vein pattern and make it suitable for the recognition purpose. Identification of human being is done with the new software WEKA; it can bring the percentage of similarity between the trained data and test data become more accurate. Experimental result shows that this approach is more promising to improve sclera recognition for personal identification.

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