DEVELOPMENT OF A DUAL AUTHENTICATION SYSTEM USING IRIS AND SCLERA FEATURES

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Abstract- Multimodal biometric system in recent days has become more popular, because single biometric systems slows down and fail also in some cases especially if it is used for security applications in various capacities. Single biometric system shows certain disadvantages, non-universality, spoof attacks etc. Iris is unique part of the eye that is varied from person to person. Iris is white part of the eye and it covering the sclera. The accuracy of the iris recognition system depends on the image quality of the iris images and also iris recognition requires frontal gaze images of the eye. The sclera is the white section of the eye, is the opaque, rubbery, defensive, external layer of the eye containing collagen and elastic fiber Images of sclera vessel patterns are often defocused and saturated and most significantly, the vessel structure in the sclera is multilayered and has complex nonlinear transformations, sclera recognition system is not give sufficient accuracy. So current research is to develop multimodal authentication system using features of iris and sclera for an accurate and efficient recognition system. In this superlatively develop iris and sclera recognition system and then fusing together. Results proved that Intelligent Recognition System using Iris and Sclera Features developed is more accurate and efficient as compared to other single biometric systems.

Keywords- Biometrics pattern extraction, Iris recognition, Sclera recognition, Dual authentication, Pattern Recognition.

I. INTRODUCTION

Biometrics is the identification of humans using intrinsic behavioral, genetic, or physiological characteristics, traits, or habits. Examples of biometric modalities include iris, face, hand, fingerprint, gait, typing, speech, and others. In general, biometrics can be classified into two broad categories. Physiological and behavioral biometrics. Identify an individual from an intrinsic physiological trait is the physiological biometrics for example iris, face, fingerprint, etc. and from behavioral trait is the behavioral biometric such as gait, typing, etc. Biometric systems can check much larger databases, more consistent, and can be cheaper to operate.

Most existing iris recognition systems use algorithms originally developed by John Daugman. These systems require well-focused, forward look, well-centered, high quality images of the eye acquired in the near-infrared (NIR) wavelengths. Most NIR iris systems acquire iris images at a distance of less one foot. This is impractical for surveillance that could be used for segmentation is lost.

Darkly colored irises perform much worse than lightly colored irises when identified using existing algorithms in the visible spectrum. This is due to the high absorption of visible light by dark colored irises, so that little of the identifying structure of the iris can be imaged and extracted. Sclera recognition is identification of a human using the sclera, white and opaque outer protective covering of the eye. For young children, the blood vessels in sclera area could be blue, but for adults, the blood vessels are red in color. The arrangement of the blood vessels in the sclera are well suited to be used as a biometric- they are an internal organ that is visible without difficulty and they are stable over time and unique for each person. Therefore, the vein patterns in the sclera could be used for positive human identification. Sclera recognition does not require imaging the eye in the near-infrared wavelengths. This allows for less constrained imaging requirements, including imaging at very long distances, may not require additional illumination and frontal gaze images of the eye.

II. STATE OF ART

Iris recognition has become an active research since the concept of an iris recognition system was first proposed by Flom and Safir [1] in 1987.

Even though the Daugman system is the most successful and most well known, many other systems have been developed. The most notable include the systems of Wildes 97[3], Boles and Boashash98 [4].

The Daugman system has been tested under numerous studies, all reporting a zero failure rate. The Daugman system is claimed to be able to perfectly identify an individual, given millions of possibilities. The prototype system by Wildes[3] et al. also reports flawless performance with 520 iris images, and the Lim et al. system attains a recognition rate of 98.4% with a database of around 6,000 eye images. He used edge detection and Hough transform for iris segmentation, 4-level Laplacian pyramid to represent the spatial characteristics for iris image feature extraction, an normalized correlation for matching but time-consuming matching process. Boles98[4] also used same segmentation as described by Wildes, but
he used zero crossing of the wavelet transform for feature extraction and two dissimilarity functions for matching, results show that it provides invariant properties and faster matching process using 1D signatures.

Ma04[5] used gray-level canny edge detection, key local variations using wavelet transform for extraction and he introduced weighted Euclidean distance concepts for matching purpose, provides invariant properties with local features. Vatsa08[6] used non-ideal iris segmentation using Mumford-Shah functional, 1D log-Gabor filters to extract the textual features Euler number for extraction, iris indexing algorithm is used for matching and his results shows that reasonable identification rate on non-ideal iris datasets with a 2v-SVM based fusion strategy.

III. RELATED WORKS

The first operational automatic iris recognition system was developed by Daughman [2] in 1993, in which Gabor features were extracted from scale normalized iris regions and quantized to form a 2K bit iris code. The recognition principle is the failure of a test of statistical independence on iris phase structure encoded by multi-scale quadrature wavelets. The Hamming distance between the iris code of the test and the training iris images was used for recognition.

In [7], Derakhshani first proposed using conjunctival vasculature patterns for user identification. The conjunctiva is the thin top layer of the sclera region, and the conjunctival vasculature is the system of veins and arteries in this layer. They used contrast limited adaptive histogram equalization (CLAHE) to enhance the green color plane of the RGB image, and a multi-scale region approach to identify the sclera veins from the image background. In [8], Derakhshani and Ross used a texture-based neural network classifier, manual segmentation of the sclera region, and adaptive thresholding and enhancement on the vasculature images. In this work, they used a database of 50 users, with images acquired in 2 sittings, with a 20 minute trail off in amid, at acquisition distances of 1, 5, and 9 feet, for total 300 images.

In [9] Crihalmeanu used an semi-automated k-means clustering algorithm to estimate the sclera region from the RGB values of the pixels in the color sclera images, and used manual involvement to correct for misclassified boundaries. They used a registration method that incorporates local affine and global smoothing transformations that locally deforms the template image to provide the best registration with the target image. Using the cross-correlation between non-specularity regions in the registered images, they report an equal error rate around 25%, using their internally acquired database of 50 users. These initial works have shown that the sclera can be used for accurate human identification. As they pointed out in the conclusion, for practical use of the sclera vasculature as a biometric identifier there is more work that is necessary.

IV. PROPOSED MODEL

This paper develops an accurate and an efficient recognition system using iris and sclera features. Sclera recognition has several technical difficulties that make it difficult to implement in practice. The eye is a moving structure, and the sclera vascular patterns move and are deformed with this movement. The sclera is reflective, so the sclera patterns may be out-of-focus or saturated. The vascular patterns in the sclera are composed of multiple layers, and as a result, there is complicated non-linear deformation of the patterns as the eye and the surrounding tissues move.

The Hamming distance between the iris code of the test and the training iris images was used for recognition.

Algorithm for sclera recognition

1. Read all input images from hard disk drive folders.
2. Then converted RGB in to grayscale image.
3. Applying horizontal Sobel filter on that image.
4. Estimation of glare area.
5. Iris boundary detection using circular iris segmentation method.
7. Iris and eyelid detection and refinement using morphological operator and Gabor filter.
8. Then save and create the iris eyelid template on hard disk drive.
9. Read an image from hard disk.
10. Then follow above steps from 2 to 6.
11. Match the iris eyelid template on database template.
12. Finally recognition results.

Canny edge detection method in iris recognition

For iris segmentation, canny edge detection is used. It is a detection operation that uses a multi-stage algorithm to detect a wide range of edges in images. This algorithm has several stages of operation. They are noise reduction, finding the intensity gradient of the image, non-maximum suppression, tracing edges through the image and hysteresis thresholding. The canny algorithm contains number of adjustable parameters, which can affect the computation time and effectiveness of the algorithm, size of the Gaussian filter and thresholds. The size of the Gaussian filter, the smoothing filter used in the first stage directly affects the results of the canny algorithm. Smaller filters cause fewer blurring, and permit recognition of small, jagged lines. A superior filter causes more smearing, blurring, out the value of a given pixel over a larger area of the image. superior blurring radii are more useful for detecting larger, smoother edges – for instance, the edge of a rainbow. The use of two thresholds with hysterisis allows more flexibility than
in a conventional threshold approach, but common problems of thresholding methods still concern. A threshold set too high can miss important information. On the other hand, a threshold set too low will falsely identify irrelevant information (such as noise) as significant. It is hard to give a standard threshold that works well on every image. No tried and hardened approach to this problem yet exists.

Otsu’s threshold method used in sclera segmentation
Otsu’s method is used to automatically perform clustering-based image thresholding or the reduction of a gray-level image in to a binary image. A measure of region homogeneity is variance (i.e., regions with high homogeneity will have low variance). This method selects the threshold by minimizing the within-class variance of the two groups of pixels separated by the thresholding operator. It does not depend on modeling the probability density functions. On the other hand, it assumes a bimodal distribution of gray-level values.

![Fig 2: Original iris image](image1) ![Fig 3: Original sclera image](image2)

V. IMPLEMENTATION

In this paper, first develop iris recognition system as a prototype. For this took a database of 20 human eye images. In this used canny edge detection method and for matching hamming distance concept is used. In the second step, develop sclera recognition system and for this also took the same database of 20 images. In this Otsu’s based segmentation is used. Finally combine the iris and sclera recognition for proper authentication and identification, because sclera itself gave not much, contains so many blood vessels. For accurate matching verification, various performance metrics are used. They are false accept rate/false match rate, false reject rate/false non-match rate, equal error rate/cross over error rate, failure to enroll rate, failure to capture rate, template capacity Mathematical modeling of proposed algorithm is given by following relations. The result obtained from iris recognition system shows that high matching rate, because in the database almost high quality images are used, that is suitable for sclera recognition also. The combined technique gives the high accuracy compared to the Daughman and Wilde’s methods. For getting high accuracy, segmentation method used plays a vital role. In Sclera segmentation, Otsu’s threshold method is used, it gives good intra-class variance.

Feature-based approach
If the template image has strong features, a feature-based approach may be considered; the approach may prove further useful if the match in the search image might be transformed in some fashion. Since this approach does not consider the entirety of the template image, it can be more computationally efficient when working with source images of larger resolution, as the alternative approach, template-based, may require searching potentially large amounts of points in order to determine the best matching location.

Template-based approach
For templates without strong features, or for when the bulk of the template image constitutes the matching image, a template-based approach may be effective. As aforementioned, since template-based template matching may potentially require sampling of a large number of points, it is possible to reduce the number of sampling points by reducing the resolution of the search and template images by the same factor and performing the operation on the resultant downsized images (multiresolution, or pyramid, Image processing), providing a search window of data points within the search image so that the template does not have to search every viable data point, or a combination of both.

Features Computation using wavelet packet decomposition
At each scale anisotropic rotationally invariant features were extracted using the Discrete Fourier Transform (DFT). If $f_q$ represents the 6 orientated channel energy values at a particular scale then the DFT is given by:

$$\hat{f}_k = \sum_{q=0}^{5} f_q e^{-imk/3}$$

for $k = 0$ to $5$

The zeroth harmonic, $\hat{f}_0$, is just the DC summation.

The magnitudes of $\hat{f}_1$, $\hat{f}_2$ and $\hat{f}_3$ (the first, second and third harmonic) can be used as anisotropic features at each scale or can be combined into single features. The recursive decomposition of the low-low sub bands results in octave frequency analysis.

This may be considered too coarse for effective texture representation. This limitation has been addressed by using a complex wavelet packet type decomposition. However, it was considered difficult to obtain meaningful rotational harmonics from further decomposed complex band pass sub bands.

Invariant Features from Autocorrelation Measures
Autocorrelation coefficients measure the degree of similarity between neighbouring data observations in a time series. Assuming the time series is $y_i, i = 1, 2, \ldots$, the autocorrelation coefficient is estimated from sampling observations.
Development of a Dual Authentication System using Iris and Sclera Features

\[
1 \leq i + k \leq 6: \quad i + k
\]
\[
i + k > 6: \quad i + k - 6
\]

Therefore for the 6 subband energy sequence, the autocorrelation measures can be seen.

\[
r_k = \frac{\sum_{i=1}^{n} (y_{i} - \bar{y})(y_{i+k} - \bar{y})}{\sqrt{\left[\sum_{i=1}^{n} (y_{i} - \bar{y})^2\right] \left[\sum_{i=1}^{n} (y_{i+k} - \bar{y})^2\right]}}
\]

where \(r_k\) describes the autocorrelation of \(y_i\) and \(y_{i+k}\). For the cyclic signals such as the 6 sub band energies described above, the denominator simply becomes the variance and the lagging variable in the numerator simply raps around to the start of the signal as need be.
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Table 1. Comparison of PSNR w.r.t Hamming Distance

<table>
<thead>
<tr>
<th>SR. NO</th>
<th>NO OF DATA SAMPLES</th>
<th>HAMMING DISTANCE</th>
<th>PSNR</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>0.26</td>
<td>23.56</td>
</tr>
<tr>
<td>2.</td>
<td>2</td>
<td>0.31</td>
<td>24.12</td>
</tr>
<tr>
<td>3.</td>
<td>4</td>
<td>0.33</td>
<td>26.48</td>
</tr>
<tr>
<td>4.</td>
<td>6</td>
<td>0.35</td>
<td>31.56</td>
</tr>
<tr>
<td>5.</td>
<td>8</td>
<td>0.37</td>
<td>30.12</td>
</tr>
<tr>
<td>6.</td>
<td>10</td>
<td>0.39</td>
<td>31.15</td>
</tr>
<tr>
<td>7.</td>
<td>12</td>
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<td>9.</td>
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<td>38.16</td>
</tr>
<tr>
<td>10.</td>
<td>18</td>
<td>0.47</td>
<td>39.45</td>
</tr>
</tbody>
</table>

Fig 5: Iris localization results from (a to h)

Fig 6: Data samples and hamming distances used for iris recognition

Fig 7: Graph showing hamming distances for the same person

Table 2. Comparison of Localization Techniques

<table>
<thead>
<tr>
<th>METHODS</th>
<th>ACCURACY</th>
<th>FAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAUGHAHN</td>
<td>99.37</td>
<td>0.05</td>
</tr>
<tr>
<td>WILDES</td>
<td>99.38</td>
<td>0.02</td>
</tr>
<tr>
<td>CORNER DETECTION METHOD</td>
<td>99.25</td>
<td>0.03</td>
</tr>
<tr>
<td>PROPOSED</td>
<td>99.45</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Fig 8: Various methods with accuracy rates

Fig 9: Graph showing the comparison between various methods based on FAR

Fig 10: Graph showing comparison between various methods based on accuracy rate

CONCLUSION AND FUTURE WORK

In this paper mainly gives the idea about how to achieve better accuracy and efficient recognition system using both iris and sclera features and used highly accurate segmentation method for extracting feature from the background. Because if only iris is used, it will not give much accuracy. Other than that, nowadays multimodal biometrics plays a major role in personal identification purposes. As a future work, we can use this idea to other biometrics also.

REFERENCES


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