Elegant Extraction of Iris using Fuzzy Pupil Tracking System

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ABSTRACT

In recent years visual recognition of a human being is essential for every aspect of our life concerned with security and identification. The best unique feature in a human's face is Iris. Iris based identification is one of the special features of biometrics. The iris recognition technology is almost advanced with many important benefits, such as fast, precision, hardware, clarity and relevance. The structure of iris is having web like sense with plentiful overlays and design. Here we proposed a new technique which tracks the movement of pupil. The pupil movement is handled as a major part in our process, and then the distance between the pupil and collarets is calculated. To obtain this, here we are using Elegant Fuzzy Pupil Tracking algorithm (EFPT). The iris recognition system is having a segmentation system which is based on the Hough transform. From this we can possible to localize the iris, pupil region, eyelids, eye lashes and reflection. Initially the image of user's eye is captured by our webcam. The captured image is normalized and recognized using the proposed tracking algorithm. Finally the matching is verified. This recognition methodology gives better performance and will be simple and effective.

Keywords: Fuzzy, Pupil, Tracking and Recognition.

1. INTRODUCTION

Now-a days authentication and identity of individuals is continually increasing in most of the real time applications such as entry in airport, organization and ATM transactions. Historically passwords, keys, certificates, etc., are useful to spot the individuals. Among these biometrics plays a vital role. Biometric identification employs physiological & behavioral characteristics to authenticate an individual’s identity. Usually these biometric features are unique to each individual & stay unaltered in the coursework of a lifetime of an individual. These features lead the biometrics towards an optimal solution for security issues.

Even though so many biometric components are available, Iris recognition system (IRS) got fame because of its uniqueness and high security. It is accepted as one of the most accurate and reliable traits and used in distinct domains such as airport, refugee control, security system of car, etc. No two irises are alike. There is no detailed correlation between the iris patterns of even identical twins or the right and left eye of an individual. The amount of information that can be measured in a single iris is much greater than fingerprints. It is extremely difficult to surgically tamper the texture of the iris. Further, it is rather easy to detect artificial irises [1]. The measures used to access the performance of biometric systems are False Accept Rate (FAR), False Reject Rate (FRR) and Equal Error Rate (EER).
1.1. General structure of Iris

In an eye image of a person (Figure 1), iris is an annular part between the pupil and the white sclera. The iris part has a number of characteristics such as freckles, corneas, stripe, furrows, crypts etc. which constitutes what is called iris features.

Iris features are distinct from one person to another. Human iris recognition process is basically divided into two phases. The phase, which is dealt with the extraction of iris features from an eye image and stores them into database, is called the “enrollment process”. At the time of matching we capture the iris features of a human and compare it with the stored features, which are called the “matching process” [2].

1.2. Processing steps in IRS

Technically, IRS consists of five main processing steps namely Image acquisition, Image segmentation, Normalization, Feature Extraction and finally Matching which is depicted in Figure 2. Among these, feature extraction plays an important role. The basic iris code algorithm for feature extraction was developed and patented by Dr. John Daugman. The extracted iris patterns are encoded using 2D Gabor wavelet demodulation (512 bytes) in order to construct the iris code which is of length 256 bytes. After developing the iris code, the captured iris record is compared with the one stored in the database.

Hamming Distance is used as a measuring component which intern uses XOR operator to detect the disagreement between two iris-codes. From the 11mm diameter iris, Daugman’s algorithms provide 3.4 bits of data per square mm. This density of information is such that each iris can be said to have 266 unique “spots”, as opposed to 13–60 for traditional biometric technologies (i.e. fingerprint). Daugman concludes that 173 “independent binary degrees-of-freedom” can be extracted from his algorithm—an exceptionally large number for a biometric [3].

2. RELATED WORK

Because of its less limitation so many research methods have been proposed for Iris Recognition so far. Daugman [4], [5] was first proposed an algorithm for iris recognition. His algorithm is mainly based on Iris Codes. Integrodifferential operators are used to detect the centre and diameter of the iris. The image is converted from cartesian to polar transform and rectangular representation of the region of interest is generated. Feature extraction algorithm uses the complex valued 2D Gabor wavelets [2], [6] to generate the iris codes which are then matched using Hamming Distance. The algorithm gives the accuracy of more than 99.99%. Also the time required for iris identification is less than one second.

Dr. L. M. Waghmare proposed an efficient methodology for identification and verification.
for iris detection, even when the images have obstructions, visual noise and different levels of illuminations. He uses the CASIA iris database which will also work for UBIRIS Iris database has images captured from distance while moving a person. His proposed research work is to enhance the algorithm for efficient person identification for other area of applications by increasing FRR more than 0.33% as the VeriEye algorithm [7] results with FRR 0.32% and FAR 0.001%.

Wavelets iris recognition algorithm is well suited for reliable, fast and secure person identification. Wavelet, Gabor filter and the range of hamming distance for Haar wavelet is less i.e., 0.2866 to 0.5111, for robust and fast matching for healthcare application for patient identification[8].

Samarth S. Mabrukar and his team proposed a model which uses Daugman’s Rubber Sheet Model to normalize the iris pattern for making computations easy. Feature Extraction is done by using multi-scale Taylor series expansion of the iris texture. Feature vectors are extracted by binarizing the first and second order multi-scale Taylor coefficients. This algorithm was tested against different images which gave better results in less computation time. The simulation was carried out using CASIA database on MATLAB [9].

Raida Hentati proposed a new algorithm for Iris recognition to reduce the error rate which uses Gabor filter and Hough Transform. His team developed an algorithm using C++ and library Open CV. They tested the algorithm on the CASIA database. The iris verification processing is executed in 155ms and gives an overall accuracy of 92.04% with FAR of 1.58% and FRR of 2.34% [10].

C.M.Patil and Sudarshan Patulkulkarni proposed an algorithm for iris feature extraction using lifting wavelet transform. The Lifting (integer) wavelet-based algorithm enhances iris images, reduces noise to the maximum extent possible, and extracts the important features from the image. Then the similarity between two iris images is estimated using Euclidean distance and comparison of threshold. This technique is computationally effective with recognition rate of 99.97% on iris database. This approach will be simple and effective [11].

Mahmoud Elgamal, Nasser Al-Biqami proposed a new approach for iris image compression and feature extraction based on discrete wavelet transformation (DWT). The obtained features dimensionality were further reduced by using principle component analysis (PCA), which drastically reduces the size of theiris database images. In the matching stage, a supervised classifier introduced, namely, k-nearest neighbor (k-NN). The classification attained was 99.5%. This result shows that the proposed technique is robust and effective compared with other recent works [12].

Jong-Gook Ko et al proposed a novel iris recognition method. This method employs iris feature extraction using a cumulative-sum-based change analysis. In order to extract iris features, a normalized iris image is divided into basic cells. Iris codes for these cells are generated by the proposed code generation algorithm which uses the cumulative sums of each cell. The method is relatively simple and efficient compared to existing methods. Experimental results show that the proposed approach has good recognition performance and speed [13].

3. PROPOSED METHODOLOGY

To perform the iris recognition, user’s iris image must be captured and located at first stage. Then the details have to encode for computations and calculations. For instance, fuzzy string code is used. Finally, the data must be saved for matching the encodings. The results are performed in MATLAB 12a. In addition to this Elegant Fuzzy Pupil Tracking algorithm make the process for efficient result retrieval. And it reduced the time complexity of the process.
Figure 3. Boundaries of the iris

The iris shown in the above figure (Figure 3) having two circles (inner and outer). One is the iris-sclera boundary (Outer circle) and another boundary (inner circle) is the iris-pupil perimeter. Segmentation and boundary disclosure is implemented in two levels. The first level is to isolate the certain iris region in a digital eye image. The eyelids and eyelashes normally congest the upper and lower parts of the iris region. Also, specular reflections can occur within the iris region which may crook the iris design. Hence next level of segmentation approach is needed to isolate eyelids and exclude these artifacts in addition to locate the circular iris region.

3.1. Processing Steps of Proposed technique

The proposed technique may be divided into five main functional blocks. They are depicted in the Figure 4.

3.1.1. Iris pattern collection item set

The pattern collection object set is the initial process to collect the datasets. The training sets are collected from the real world or they may have been taken from the existing datasets. This is called Training set. Such images are grouped and tested through the image processing technique. The irises are captured and that collective images may have distinct sizes, and characteristics.

3.1.2. Normalized pattern item recognizer

Normalization is a process of formalizing the data. It is important because, it allows vast amount of data into very low memory space and also enhanced the performance. An image encircling person eye region is achieved at a distance from a camera without any physical touch to the device. That image shows the device configuration for acquiring human eye images. The size of the image acquired under this circumstance is 320 by 240.

The captured image is not having only the "favorable" parts such as iris and pupil. But also some "appropriate" parts (eyelid, eyelashes). Under some restrictions, the brightness is not evenly distributed. In addition, eye-to-camera distance may decide the image sizes of the same eye. For the purpose of analysis, the original image needs to be processed. The localization of iris image is converted into strip [6]. The comparing is done after convert the Cartesian coordinates into its polar equivalent using

\[
L(a(\sigma, \theta),b(\sigma,\theta)) \ L(\sigma,\theta) \ \text{with} \\
\begin{align*}
    a_i(\sigma, \theta) &= a_i(\sigma) + q_i \ \cos(\theta) \\
    b_i(\sigma, \theta) &= b_i(\sigma) + q_i \ \sin(\theta) \\
    a_j(\sigma, \theta) &= a_j(\sigma) + q_j \ \cos(\theta) \\
    b_j(\sigma, \theta) &= b_j(\sigma) + q_j \ \sin(\theta)
\end{align*}
\]

which \(q_i\) and \(q_j\) are appropriately the radius of pupil and the iris in above equation, while \((a_i(\theta),b_i(\theta))\) and \((a_j(\theta),b_j(\theta))\) are the coordinates of the pupil and limbic boundaries in the direction \(\theta\). The value of \(\theta\) lies between \([0; 2\pi]\), \(\sigma\) belongs to \([0; 1]\). The converted iris image contains of marks taken from the pupil boundary to the outer iris boundary. Thus the identical set of marks is taken for each image. The iris image is formalized so that the size of
strip does not alter for different images. The size of identical iris image may change due to development and expansion of pupil. Thus the size of iris strip is fixed for each iris image.

3.1.3. Recognizer mean of item pattern
The different images are captured and stored in a dataset. While we compared the one with another, some of them are not to identical with our testing image. In order to detect the actual rate of the image, the mean has been calculated. Not all images have to same for this mean value has been calculated. The difference between the actual image and input image is computed through the mean.

3.1.4. Elegant Extraction from fuzzy pupil set
Consider the two testing iris images. When compared these with an existing database images, the proposed algorithm found the relevant image. The fuzzy set will return 0 if there lots of different signs between them otherwise it turn to 1. Even though the pupil moving around, the theta (θ) can be find out and extract the perfect features of the pupil [7].

3.1.5. Elegant Extraction pupil analysis
The iris and pupil analysis is done by two ways. They are Iris localization and Edge detection.

a. Iris Localization
In this stage, we should define an iris part of the image by localizing the area of the image derived from interior the limbus which is the outer boundary and external the pupil which is the inner boundary, and finally convert the iris part into a relevant representation. Because there is some apparent difference in the anxiety around each boundary, an edge exposure method is easily adapted to acquire the edge details.

b. Edge Detection
It is used to detect complicated object boundaries by indicating potential edge points corresponding to places in an image where rapid change in brightness occurs. After edge points have been indicated, they can be combined to form lines. Edge detection operators are based on idea that edge details in an image is found by looking at the contact of a pixel with its nearby. In other words, edge is determined by discontinuity in grey values. An edge isolates two distinct objects.

The proposed technique is finding the exact iris and pupil movement in the eye. And also it is very helpful to recognize the appropriate iris and pupil identification. Below images are shown the step-by step process to detect the exact pupil and iris region [8].

3.2. Fuzzy based TrackingAlgorithm
The proposed algorithm is computed using the fuzzy binary technique. The following is the algorithm which explains the iris recognition.

Proposed Algorithm
Input: Pupil P for iris pair (e, f)
Output: set of extract pair match iris recognition reduced time Tp.
Step1: Find extraction pupil matching accuracy
Step2: Calculate Correction point of pupil Scan
Step3: Add matching iris of pupil pairs
Step4: Add matching pair Recognition
Until pointing accurate matching recognition region and extracting time matching recognition.
Step5: Implementation of Pupil Pattern Normalization

Using this algorithm, the location of the iris and pupil can be tracked efficiently. The angles are used to find the appropriate location and track it in a right axis of the pattern.

4. IMPLEMENTATION PROCESS

Implementation is to accomplish the entire tasks of the process successfully and fresh technique is proposed to fascinate the demand of the project. The tests of the irises are picked from the entire training set databases or real time and proceed with Fuzzy based Tracking Algorithm.
MATLAB 12a is used for implementing the code. First, an image includes the user's eye taken by the system. Then, the images pre-processed to organize the scale and illumination of the iris and confine the iris design are extracted. At last verification/identification is made by the means of matching.

5. EXPERIMENTS AND RESULTS

The following figures explain the efficiency of the proposed system. Using proposed methodology, initial image shows the exact localization of the iris (inner layer) and pupil (outer layer). Then next image detects the (theta) angle of the iris. Third image finds the angle of the pupil region. Finally, eyelashes, eyelids are totally omitted and the exact position of the iris and pupil angle has been found.

5. a) Normal Eye Boundaries

5.b) Focused inner boundary of pupil

5. c) Focused outer boundary of Pupil

5. d) Eye lashes and eyelids beyond the boundaries excluded

The proposed algorithm was applied to the images of the eye image dataset. The dataset is collected by the real world people and it has 756 eye images from 108 individuals. These images are captured under infrared light, thus they are grey images, and have no reflection of the environment. The process is averagely takes 2 seconds to finish on a machine. Table 1 gives the comparison of feature extraction time and recognition time.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Methods</th>
<th>Elapsed Time</th>
<th>Recognition Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Daugman</td>
<td>682.5 ms</td>
<td>99.37</td>
</tr>
<tr>
<td>2</td>
<td>Boles</td>
<td>170.3 ms</td>
<td>92.61</td>
</tr>
<tr>
<td>3</td>
<td>Li Ma</td>
<td>244.2 ms</td>
<td>94.33</td>
</tr>
<tr>
<td>4</td>
<td>Tan</td>
<td>426.8 ms</td>
<td>97.25</td>
</tr>
<tr>
<td>5</td>
<td>Cumulative sum-based Technique</td>
<td>182.0 ms</td>
<td>98.21</td>
</tr>
<tr>
<td>6</td>
<td>Proposed</td>
<td>173.21 ms</td>
<td>98.78</td>
</tr>
</tbody>
</table>

Table 1. Comparison of Feature Extraction Time And Recognition Rate

6. CONCLUSION

Experimental results show that the proposed Iris Recognition system is more reliable with accuracy of 98.78%. This methodology is able to localize the boundary of iris and pupil, excluding eyelids and eyelashes, and reflections. Also it reduces the time complexity. It takes only a very few seconds to identify the person. Even though it performs exactly, nevertheless there are still a number of problems which need to be addressed. Initially, the automatic segmentation was not perfect. i.e., it could not successfully segment the iris regions for all of the eye images in the two datasets. If time has available, it would have been beneficial to reduce the confidentiality on mode for testing and the process that the images are manually, in order to ensure that every iris was placed correctly in the image. This will enhance the result in future. In order to enhance this system,
a much better elaborate eyelid and eyelash detection system could be achieved.

7. REFERENCES


