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Iris Recognition using Random Forest Classifier

Prasad Satosh Padalkar
Prasad.padalkar5@gmail.com

Lalit Prakash Patil
Lalitpatil5589@rediffmail.com

Abstract – **This study discusses the use of iris recognition for biometric identification in situations that demand a high level of security, such as prisons. The human iris database photographs are processed using an image processing approach. It determines the iris's centre coordinates as well as its radius. The iris image is also subjected to noise reduction. The collected features are used as inputs for the random forest classifier, which generates a class for the person's identification. A hybrid approach to feature extraction is proposed in this study, which uses a combination of Gabor wavelet and Harris Corner methods. The collected characteristics are classified using a random forest classifier. The simulation results are put to the test against publicly available data.**

Keywords: RF, Harris, Gabor, etc.

I. Introduction

Intelligent systems for the identification and verification of persons have become a very useful tool and a very intriguing subject of research as a result of recent developments in information technology and the requirement for greater security standards. Biometric technology, which uses physiological traits to distinguish persons, has supplanted traditional techniques (cards, keys, etc.). Biometrics based on the iris pattern, for example, are known for their excellent stability and discriminating capability [1].

In terms of recognition accuracy, methods for identifying persons from iris images have very low false acceptance or false rejection errors. Despite its high performance, however, there are still certain issues with the identification procedure. The segmentation and normalisation of the iris are particularly problematic. Inaccurate segmentation results in an erroneous assessment of the iris region, which results in an erroneous iris profile [2]. Inadequate normalising of the iris region results in non-optimized iris texture sampling and representation. When comparing the iris profiles of the same class, the influence of these two issues is seen as a slight correspondence, which increases recognition errors.

Furthermore, a better understanding of the existence and position of the iris' discriminant information allows for improved normalisation. In comparison to other sections of the iris, a normalising procedure created with this knowledge in mind can favour areas of the iris that are rich in discriminating information [3].

As a result, it is possible to improve the way the iris is segmented and subsequently standardised. It is vital to improve the recognition system's recognition performance by raising the rate of correct identification [4].

Several biometric technologies exist, including iris recognition, which uses the iris as a unique form of identification to grant or refuse access to secure and sensitive places. Iris recognition is frequently mistaken for a retinal scan. An iris identification system takes a picture of the eye and analyses the colour around the pupil. Iris recognition, for example, will record an image of the iris' texture, whereas a retinal scan will capture an image of the structure of the eye's blood vessels. It's considerably easier to photograph the iris than the blood vessels since the iris is visible while the blood vessels aren't.

II. System Model

A sequence of general processes must be followed in a biometric identification system (not all of them should be followed at all times), as indicated in Figure 1.

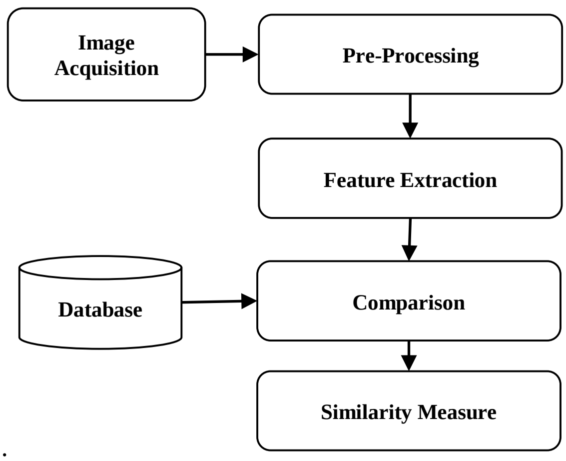

Figure 1: General stages of a biometric iris identification system

In the case of iris-based identification systems, each of these stages requires the completion of a collection of acts, which are explained below:

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A. Acquisition
It is the process of using a specialised instrument to obtain an image of the iris.

B. Pre-processing
The segmentation, standardisation, and improvement stages are all part of this step:

- The iris is separated from the rest of the picture during the segmentation stage. Correct identification can be difficult if the iris is not isolated correctly.

- Because the size of the pupil varies in each photograph, it's likely that the image of the isolated iris is independent of it during the normalisation stage. The circular portion of the iris is transformed into a rectangular zone with constant dimensions when the image is normalised. By changing and preparing the normalised image for the extraction step, the improvement stage prepares it for the extraction stage.

A. Feature Extraction

B. The representation of each image (or iris) is obtained at this stage in order to compare it to the rest of the photographs. Different approaches can be employed to extract the features of an image during the extraction step, including DWT, Gabor wavelet, and others.

C. Comparison

At this point, a measure of difference between the compared templates is produced, and it is decided if the codes were created by the same iris or not based on this measure. The Hamming Distance and the Euclidean Distance are two of the most commonly utilised approaches for performing verification (determining if the person is who they claim they are) or identification (determine the identity of an individual, comparing the image against the entire Database).

III. Proposed Methodology

It is proposed to represent the textural features of the iris based on the results obtained by [6] and their flexibility for fusion based feature extraction in biometric recognition of the iris. Figure 2 depicts the new proposal's flow diagram, which depicts the idiosyncrasies of the utilisation of various features during the trait extraction stage.

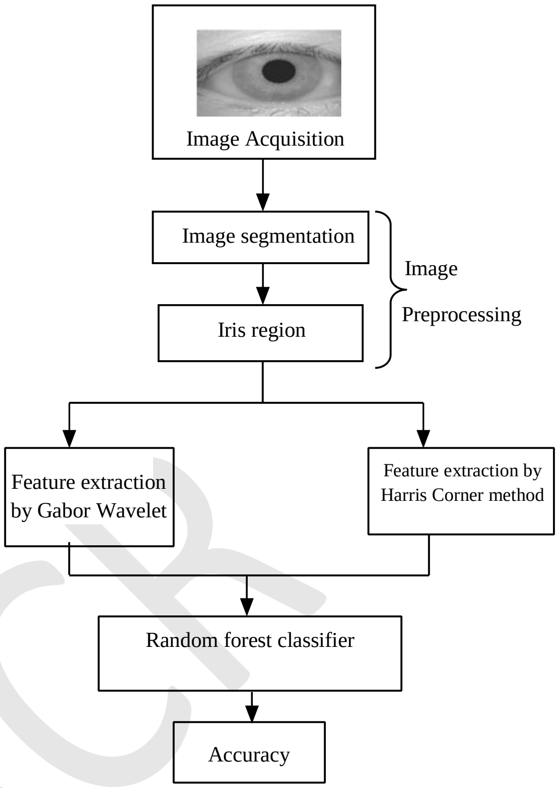

Figure 2: Flow diagram for proposed approach

The main steps of the method will be explained below:

A. Pre-Processing

We used the CASIA iris picture database, which is a database of human iris images acquired from publicly available databases.

1) CASIA Iris Image Database: The database has 108 image folders, each with seven images. As a result, there are 756 iris picture samples in the CASIA database [7].

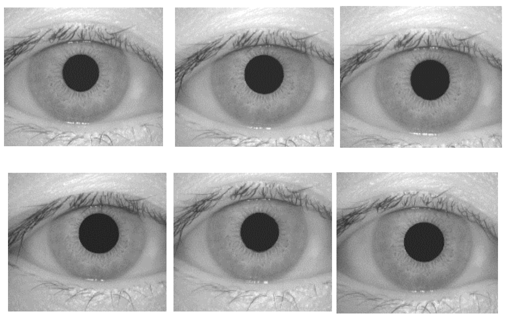
Figure 3: Sample images from CASIA dataset [7]

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B. Obtaining the iris and pupil's centre and radius coordinates. The process begins with edge detection using the canny approach; after that, the image is gamma adjusted; a non-maximum suppression is applied to the resulting image; and last, the threshold method is applied to the image.

C. Finally, the Hough transform is used to determine the maximum in the Hough space and, as a result, the circle's parameters (row and column of the centre of the iris and its radius).

D. The identical approach is used to find the coordinates of the centre and radius of the pupil, with the exception that the coordinates of the centre and radius of the iris are taken into account at the end.

E. Feature Extraction

Two feature extraction methods are used for proposed Iris recognition.

1) Gabor Wavelet

The directional decompositions for image analysis were probably initiated by Gaussian windowing in the 2D Fourier domain, and continued 4D filters as well as the directional Gabor wavelets proposed by J. Daugman [9]. The use of Gabor's wavelets for the image is often linked to the consideration of the human visual system.

Gabor wavelets are constructed by isotropic Gaussian windowing of a complex plane wave of frequency F in direction θ [10]:

$$\psi^{\theta}(x) = \frac{e^{-\|x\|^2/2}}{2\pi} e^{-j(x^T\omega_0)} \qquad (1)$$

Where, $\omega_0 = F[\cos(\theta)\,;\sin(\theta)]^T$

The decomposition depends on the number of orientations K that one fixes, and that one can distribute evenly in $[0, \pi]$.

$$\theta \in \Theta = \left\{\frac{k\pi}{K}; 0 \le k \le K\right\} \qquad (2)$$

We can then decompose any real 2D signal (x) by scalar product with the following atoms:

$$\left\{\psi_{j,u}^{\theta}(x) = 2^{-j}\psi^{\theta}\left(2^{-j}(x-u)\right)\right\}_{\theta\in\Theta, j\in\mathbb{Z}, u\in\mathbb{R}^2} \quad (3)$$

2) Harris Corner Method

Harris corner detection is a post-processing technique that is utilised for grin recognition, eye detection, and other applications [11]. The corners in the iris image I I must be detected by Harris corner detector. In order to create a gradient image, I I is first used to filter it using a Gaussian Mask. The Harris corner approach [11] is then applied.

F. Classification by using Random Forest Classifier

By introducing a de-correlation criterion between these trees, the random forest methodology modifies the Bagging method used here on trees. The goal of this strategy is to diminish correlation without drastically raising variance. The idea is to pick a subset of variables at random to consider at each level of the tree's optimal node selection process.

Consider a training set S=(x 1,y 1),...,(x m,y m), where the number of attributes of the examples of X is the number of attributes of the training set.. Also consider S_t a bootstrap containing m instances obtained by resampling with replacement of S. Let $\{h_1, \ldots h_t\}$ be set of T decision trees. Each tree h_t is built from S_t. For each node of the tree, the partitioning attribute is chosen by considering a number $f(f < a)$ of randomly selected attributes (among the attributes a). To classify a new instance x, the random forest classifier performs a uniformly weighted majority vote of classifiers in that set for instance x. The algorithm illustrates this principle [13].

Algorithm:

Input: $S = \{(x_1, y_1), \ldots, (x_m, y_m)\}$, *the training set.*

Input: T, *the number of decision trees in the random forest.*

For $t = 1, \ldots, T$ *do*

1. *Generate a Bootstrap sample* S_t *of size m from S*
2. *Create a decision tree* h_t *from* S_t *by recursively repeating for each node of the tree the following steps:*
   a. *Randomly select* f *attributes among a attributes.*
   b. *Choose the partitioning attribute among f*
   c. *Partition the node into two child nodes*

End for

Output: H*, the random forest classifier*

IV. Simulation And Results

MATLAB (2014a) based simulation scenario has been developed.

Table 1: Comparative analysis

Method	Classifier used	Accuracy (%)
Cross-sensor Iris Recognition Performance using IIITD CLI Database [14]	Naive Bayes Nearest Neighbor Classification	90.34%
Proposed Approach using CASIA Database	Random Forest Classifier	98.9%

V. Conclusion

Iris recognition is one of the most accurate biometric procedures currently available. Pre-processing, particularly iris segmentation, is critical in an iris identification system. Canny edge detector is used to segment the raw iris picture. With the random forest

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classifier, additional hybrid features (Gabor wavelet + Harris Corner) are used. With the CASIA database, this effort achieved a maximum accuracy of 98.9%, whereas the IITD CLI database had a maximum accuracy of 93.2 percent. It will be interesting to see how iris feature extraction progresses in the future, based on iris photos accumulated in the past For example, in less regulated situations or under various lighting circumstances.

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