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Research Paper

Feature Extraction of an Iris for Personal Authentication Based on Gabor Wavelet

Engineering

KEYWORDS : Iris recognition, biometrics, Gabor wavelets, and Hamming, Distance

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ABSTRACT

An accurate biometric identification system is a critical requirement in a variety of applications. Iris recognition, as an emerging biometric recognition approach has an increasing emphasis on security and has become a popular research and practical applications in recent years due to its reliability and nearly perfect recognition rates. In this paper, we present a novel approach to iris recognition. Our goal is to develop a Log-Gabor Wavelet based algorithm that enhances iris images, and extracts the important features from the image. Then the similarity between two iris images is estimated using Hamming distance and comparison of threshold. The proposed technique is computationally effective with recognition rate of 99.97% on iris database. This approach will be simple and effective.

I. Introduction

Most traditional methods of security require a person to possess some type of physical possession, such as a key, or to know certain information, such as a password. These techniques are not as secure as organizations may desire. In recent years, the increasing capabilities of computers have allowed more sophisticated and intelligent personal identification methods. Biometric techniques [1] [2], which use uniquely identifiable physical or behavioral characteristics to identify individuals, are one such method. Commonly used biometric features are the face, fingerprints, voice, DNA, retina, and the iris. Iris recognition is thought to be one of the most reliable methods of biometric identification. It involves using photographs of a person's eye(s) to determine the identity of the individual. The iris contains unique features, such as stripes, freckles, coronas, etc. [4], collectively referred to as the texture of the iris. This texture is analyzed and compared to a database of images to obtain a match. The probability of a false match is close to zero, which makes iris recognition a very reliable method of personal identification. This paper discusses a Log-Gabor Wavelet based algorithm for iris image enhancement, feature extraction, and matching. Following this introduction, we briefly review related works. In section 3, we discuss our proposed methodology for iris recognition. Section 6 & 7 is our result and conclusion.

II. Related Work

In this section, we discuss techniques that have been used in iris recognition. Though the theory behind iris recognition was studied as early as the 19th century, most research has been done in the last few decades [5], [6], [7]. Daugman [8] used a multiscale quadrature method and used Hamming distance for matching. Boles and Boashash [9] used a zero-crossing method, with dissimilarity functions for matching. Wildes et al. [10] used a Laplacian pyramid for analysis of the iris image. Lim et al. [11] used a 2D Haar transform to extract iris data. Ma et al. [12] used multichannel Gabor filtering to extract important data. Tisse et al. [13] used a Hilbert transform for extraction. In later research, Ma et al.[4] used a different spatial filter to extract features. The iris has a complex texture. Manchester Metropolitan University (MMU) iris database [22] contributes a total number of 450 iris images which were taken using LG IrisAccess®2200. This camera is semi-automated and it operates at the range of 7-25 cm.The iris is not believed to change drastically over time, and so a database of images should be reliable for a long time [4]. The technique described in Daugman's [5] paper uses wavelets for demodulation of the iris image to extract twodimensional modulations which are turned into what is referred to as an IrisCode. The extracted IrisCode is compared to an IrisCode in a database, and if it is similar enough, it is considered a match. Most iris recognition used today is based on this method [5]. Ma et al. use a technique which first converts the round image of the iris into a rectangular pattern, essentially by "unwrapping" the circular image. Filters are then used to obtain the frequency distribution of the image. This data is used to make a match in the iris database. According to the research of Ma et al., this technique is inferior only to Daugman's method [4].

The technique proposed in [14], used to detect the inner and outer boundary of an iris using wavelet approximations.

III. Proposed Methodology

In this section, we discuss our proposed methodology for iris image recognition. Figure 1 shows the process that will be used. The process involves seven modules and a database.

A. Data Collection

The first phase of our method is to collect a large database consisting of several iris images from various individuals, and we selected MMU (Manchester Metropolitan University) database for the implementation.

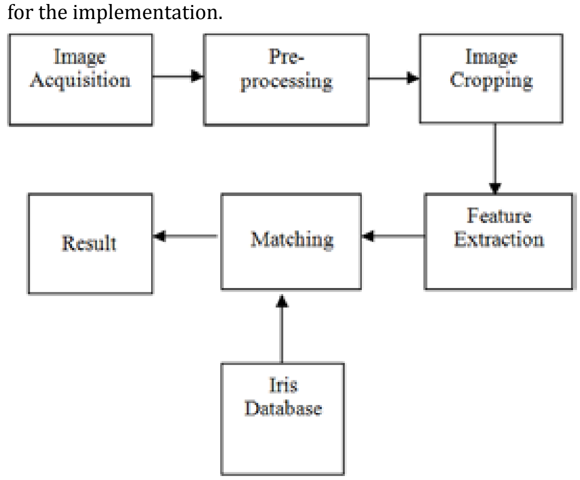

Figure 1: Flowchart of our Methodology.

B. Image Pre-Processing

The image is pre-processed to reduce the noise and secular reflections as much as possible to improve the quality of the image shown in Figure 2.

- Must reduce the papillary area to pure black, in order to properly recognize the inner pupillary boundary.
- Must be capable of removing bright flashes present in the image.

C. Inner and Outer boundary detection

In this stage, the iris boundaries in the image of the eye are determined. It iris is the

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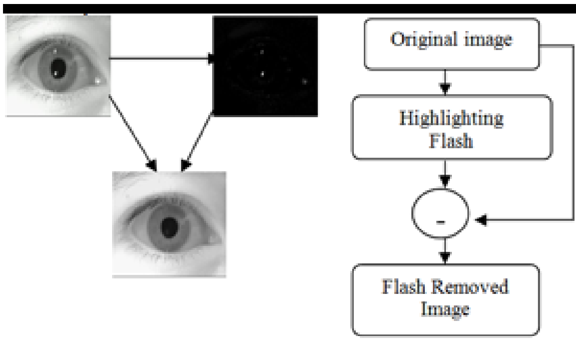


Figure 2: Removal of Bright flashes.

portion of the image between the pupil and the sclera and outside the pupil. The technique proposed in [14], used to detect the inner and outer boundary of an iris using wavelet approximations. Figure 3 shows the process that will be used.

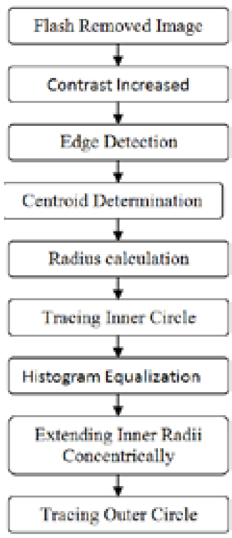
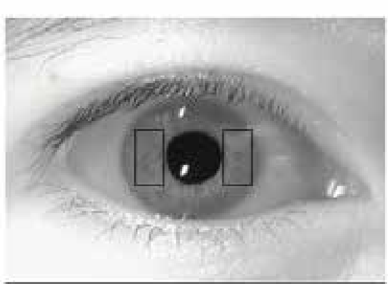


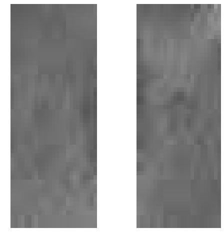
Figure 3: Flowchart of iris inner and outer Boundary detection.

D. Image Cropping

Cropping refers to the removal of the outer parts of an image to improve framing, accentuate subject matter or change aspect ratio. Depending on the application, this may be performed on a physical photograph, artwork or film footage, or achieved digitally using image editing software. Image cropping is obtained by drawing the tangent lines to the inner and outer boundaries. Figure 4 shows the cropped image.



(i)



(ii) (iii)

Figure 4: (i) Cropped iris image (ii) Left crop (iii) Right crop.

E. Feature extraction

Feature extraction is a key process where the two dimensional image is converted to a set of mathematical parameters. The iris contains important unique features, such as stripes, freckles, coronas, etc. These features are collectively referred to as the texture of the iris. These features were extracted using following algorithms. In our approach we will focus on Log-Gabor wavelet based algorithms.

F. Log-Gabor wavelet Transform

Gabor filters have been used extensively in a variety of image processing problems, such as fingerprint enhancement [16] and iris recognition [15, 12]. The Gabor function's most interesting property is that it achieves the lower bound in the Gabor-Heisenberg- Weyl uncertainty relation between space and spatial frequency. Thus the optimum compromise, in the problem of obtaining simultaneous localization in space and frequency, is obtained with the Gabor filter.

The log Gabor function, as described in [18], is a modification to the basic Gabor function, in that the frequency response is a Gaussian on a log frequency axis, as defined:

$$G(f) = exp(-(log(f/f_0))^2/2(log(\sigma/f_0))^2)$$

The log Gabor function has the advantage of the symmetry on the log frequency axis. The Log-Gabor filters spread information equally across the channels [17].

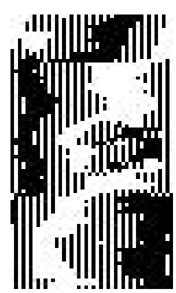


Figure 5: Image after feature extraction technique

To create iris code feature extracted image is divide into vertically 16 blocks

Step1. Normalized image size is of 64X512. We Divide normalized iris image into basic cell regions for generation of iris code. One cell region has 64 (row) ×32(col) pixels size. A Standard deviation of pixels value is used as a representative value of a basic cell region for calculation.

Step 2. Now we got 16 bit values we have to convert this into 16 bit binary value by considering the threshold as mean from each block.

Step 3. If the pixel values of is greater than threshold make it 1.

Step 4. Else make it 0

By following above step we can obtain 16 bit binary

IrisCode for Verification.

III. Matching
Once the features are extracted using Log-Gabor wavelet transforms, an iris image is transformed into a unique representation within the feature space. In order to make the decision of acceptance or refusal, a distance is calculated to measure the closeness of match. The extracted features of the iris are compared with the iris images in the database.

Hamming Distance: The hamming distance is one way of defining the closeness of match between two iris feature templates. It gives a measure of how many bits are same between two bit patterns [18]. Using the Hamming distance of two bit patterns, a decision can be made as to whether the two patterns were generated from different irises or from the same one.

$$HD = \frac{1}{N}\sum_{j=1}^{N} X_j (XOR) Y_j$$

Since an individual iris region contains features with high degrees of freedom, each iris region will produce a bit-pattern which is independent to that produced by another iris, on the other hand, two iris codes produced from the same iris will be highly correlated.

If two bits patterns are completely independent, such as iris templates generated from different irises, the Hamming distance between the two patterns should equal 0.5. This occurs because independence implies the two bit patterns will be totally random, so there is 0.5 chance of setting any bit to 1, and vice versa. Therefore, half of the bits will agree and half will disagree between the two patterns. If two patterns are derived from the same iris, the Hamming distance between them will be close to 0.0, since they are highly correlated and the bits should agree between the two iris codes [19] [20].

The Hamming distance is the matching metric employed by Daugman, and calculation of the Hamming distance is taken only with bits that are generated from the actual iris region.

The Hamming distance between two strings of bits (binary integers) is the number of corresponding bit positions that differ. This can be found by using XOR on corresponding bits or equivalently, by adding corresponding bits (base 2) without a carry. For example, in the two bit strings that follow:

```
      A       0 1 0 0 1 0 1 0 0 0
      B       1 1 0 1 0 1 0 1 0 0
A XOR B =     1 0 0 1 1 1 1 1 0 0
```

The Hamming distance (H) between these 10-bit strings is 6, the number of 1's in the XOR string.

Here is the example of how to calculate the hamming distance between two iris codes

IrisCode1:1 1 0 0 1 0 1 1 1 0 1 0 0 0 1 1

IrisCode2:1 1 0 0 1 0 1 0 0 1 1 0 0 1 0 1

Hamming distance of above two IrisCode is

HD: 0.3125

V. Result
To evaluate the performance of the proposed system, extensive experiments were performed. Iris images are obtained from MMU iris image database [22]. The experiments are done in MATLAB. The run-time results for the iris recognition are given as follows - comparing the features of the encoded images.

- Identification and verification is by comparing with database image with input image.
- The Hamming distance threshold is 0.1467.
  The run-time results for the iris recognition are given in table I which confirm that the proposed method performs faster.

TABLE I. Runtime results for iris recognition

Hamming distance Threshold	Output
< 0.1467	Authenticated
>0.1467	Unauthenticated

VI. Conclusion
In this paper, the performance of Iris recognition system by using Log-Gabor wavelet approximations for detecting singularities to extract features and capable of comparing two eye images. The proposed approach considerably reduces the computation time and improves the accuracy. Furthermore, this identification system is quite simple requiring few components and is effective enough to be integrated within security systems that require an identity check. Log-Gabor wavelet based system can be used for various security related purposes. The experimental results are encouraging and the comparison with some algorithms indicates our method is comparable to them, and the outputs of this paper are satisfactory.

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