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IRIS RECOGNITION SYSTEM USING STASTICAL FEATURE EXTRACTION

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Abstract

Biometrics deals with identification of individuals based on their biological or behavioral characteristics. Iris recognition is one of the newer biometric technologies used for personal identification. It is one of the most reliable and widely used biometric techniques available. In general, a typical iris recognition method includes capturing iris images, testing iris livens, image segmentation, and image recognition using traditional and statistical methods. Each method has its own strengths and limitations. Our goal is to develop best algorithm that enhances iris images, reduces noise to the maximum extent possible, extracts the important features from the image, and matches those features with data in an iris database. This approach will be simple and effective, and can be implemented in real-time. Experiments are performed using iris images obtained from CASIA database (Institute of Automation, Chinese Academy of Sciences) and Matlab application for its easy and efficient tools in image manipulation.

Keywords – Biometrics, Iris recognition, Image recognition.

Introduction

Biometrics involves recognizing individuals based on the features derived from their Physiological and behavioral characteristics. Biometric systems provide reliable recognition schemes to determine or confirm the individual identity. A higher degree of confidence can be achieved by using unique physical or behavioral characteristics to identify a person; This is biometrics. A physiological characteristic is relatively stable physical characteristics, such as fingerprint, iris pattern, facial feature, hand silhouette, etc. This kind of measurement is basically unchanging and unalterable without significant duress. Applications of these systems include computer systems security, e-banking, credit card, access to buildings in a secure way. Here the person or object itself is a password. User verification systems that use a single Biometric indicator are disturbed by noisy data, restricted degrees of freedom and error rates. Multi biometric systems tries to overcome these drawbacks by providing multiple evidences to the same identity hence the performance may be increased. The automated personal identity Authentication systems based on iris recognition are reputed to be the most reliable among all biometric methods: we consider that the probability of finding two people with identical iris pattern is almost zero.

The uniqueness of iris is such that even the left and right eye of the same individual is very different. That's why iris recognition technology is becoming an important biometric solution for people identification Compared to fingerprint; iris is protected from the external environment behind the cornea and the eyelid. No subject to deleterious effects of aging, the small-scale radial features of the iris remain stable and fixed from about one year of age throughout life. In this paper, we implemented the iris recognition system by composing the following four steps. The first step consists of preprocessing. Then, the pictures' size and type are manipulated in order to be able subsequently to process them. Once the preprocessing step is achieved, it is necessary to detect the images. After that, we can extract the texture of the iris. Finally, we compare the coded image with the already coded iris in order to find a match an impostor. These procedures can be viewed as depicted in fig 1

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Figure 1: The outer structure of iris

A sample iris image is shown in Fig1. Since it has a Circular shape when the iris is orthogonal to the sensor, iris recognition algorithms typically convert the pixels of the iris to polar coordinates for further processing. An important part of this type of algorithm is to determine which pixels are actually on the iris, effectively removing those pixels that represent the pupil, eyelids and eyelashes, as well as those pixels that are the result of reflections. In this algorithm, the locations of the pupil and upper and lower eyelids are determined first using edge detection. This is performed after the original iris image has been down sampled by a factor of two in each direction. The best edge results came using the canny method. The pupil clearly stands out as a circle and the upper and lower eyelid areas above and below the pupil is also prominent. A Hough transform is then used to find the center of the pupil and its radius. Daugman is the first one to give an algorithm for iris recognition. His algorithm is based on Iris Codes. For the preprocessing step i.e., inner and outer boundaries of the iris are located. Feature extraction algorithm uses the modified complex valued Gabor filter. For matching, Hamming Distance has been calculated by the use of simple Boolean Exclusive – OR operator and for the perfect match give the hamming distance equal to zero is obtained. The algorithm gives the accuracy of more than 99.9%. Also the time required for iris identification is less than one second.

IMPLEMENTATION

Image acquisition

Image acquisition is considered the most critical step in our project since all subsequent stages depend highly on the image quality. In order to accomplish this, we used a CCD camera. We set the resolution to 640x480, the type of the image to jpeg, and the mode to white and black for greater details. Furthermore, we took the eye pictures while trying to maintain appropriate settings such as lighting and distance to camera.

Image manipulation

In the preprocessing stage, we transformed the images from RGB to gray level and from eight-bit to double precision thus facilitating the manipulation of the images in subsequent steps.

Iris localization

Before performing iris pattern matching, the boundaries of the iris should be located. In other words, we are supposed to detect the part of the image that extends from inside the limbus (the border between the sclera and the iris) to the outside of the pupil. We start by determining the outer edge by first down-sampling the images by a factor of 4, to enable a faster processing delay, using a Gaussian Pyramid. We then use the Canny operator with the default threshold value given by Matlab, to obtain the gradient image. Next, we apply a Circular summation which consists of summing the intensities over all circles, by using three nested loops to pass over all possible radii and center coordinates. The circle with the biggest radius and highest summation corresponds to the outer

boundary. The center and radius of the iris in the original image are determined by rescaling the obtained results. After having located the outer edge, we next need to find the inner one which is difficult because it is not quite discernable by the Canny operator especially for dark-eyed people. Therefore, after detecting the outer boundary, we test the intensity of the pixels within the iris. Depending on this intensity, the threshold of the Canny is chosen. If the iris is dark, a low threshold is used to enable the Canny operator to mark out the inner circle separating the iris from the pupil. If the iris is light

colored, such as blue or green, then a higher threshold is utilized.

The pupil center is shifted by up to 15% from the center of the iris and its radius is not greater than 0.8 neither lower than 0.1 of the radius of the iris . This means that processing time, dedicated to the search of the center of the pupil of this part is relatively small. Hence, instead of searching a down-sample version of the iris, we searched the original one to gain maximum accuracy. Thus we have determined the boundaries of the iris as shown in Figure 2 and we can then manipulate this zone to characterize each eye.

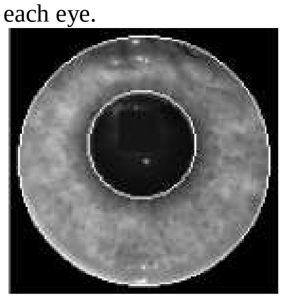

Figure2. Localized iris

Mapping

After determining the limits of the iris in the previous phase, the iris should be isolated and stored in a separate image. The factors that we should watch out for are the possibility of the pupil dilating and appearing of different size in different images. For this purpose, we begin by changing our coordinate system by unwrapping the lower part of the iris (lower 180 degrees) and mapping all the points within the boundary of the iris into their polar equivalent (Figures 3 & 4). The size of the mapped image is fixed (100x402 pixels) which means that we are taking an equal amount of points at every angle. Therefore, if the pupil dilates the same points will be picked up and mapped again which makes our mapping process stretch invariant.

When unwrapping the image, we make use of the bilinear transformation to obtain the intensities of the points in the new image. The intensities at each pixel in the new image are the result of the interpolation of the grayscales in the old image.

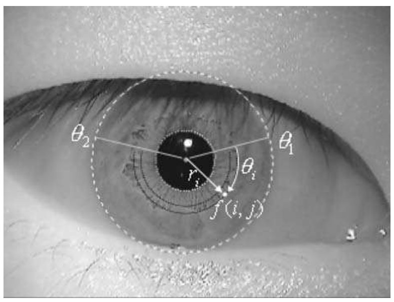

Figure 3. Mapping of the disc-shaped iris to a rectangle block

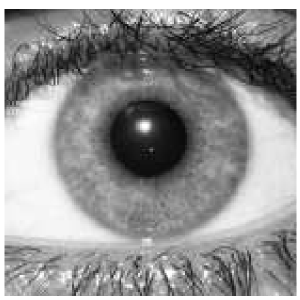

Figure5. Original Image

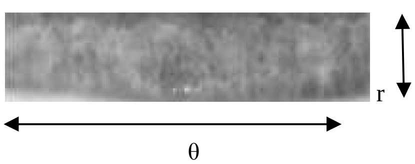

Figure6. Iris Isolated Image

Feature Extraction

In this section, we present a new feature representation method for the iris recognition. The feature representation should have information enough to classify various irises and be less sensitive to noises. In general, a high level of detail of the iris texture is sensitive to noises, while a low level of detail is less sensitive Following statistical features are extracted in this paper by using Laplacian of Gaussian filter:

1. Mean
2. Standard deviation
3. Variance and
4. Pixel correlation

Mean:

$$\bar{X} = \frac{\sum_{i=1}^{i=n} X_i}{n}$$

Std. deviation:

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{i=n}(X_i - \bar{X})^2}$$

Variance:

$$\sigma^2 = \frac{\sum f(x-\bar{x})^2}{n}$$

These extracted features are stored in the database for Identification process. Using these features; an image can be viewed as a feature vector Fc, C =1,C of that image having desired number of circles. In order to encode features, the Wildes et al. system decomposes the iris region by application of Laplacian of Gaussian filters to the iris region image. The filters are given as

$$LoG(x,y) = -\frac{1}{\pi\sigma^4}\left[1-\frac{x^2+y^2}{2\sigma^2}\right]e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Binary Coding Scheme

It is very important to represent the obtained vector in a binary code because it is easier to find the difference between two binary code-words than between two number vectors. In fact, Boolean vectors are always easier to compare and to manipulate. In order to code the feature vector we first observed some of its characteristics. We found that all the vectors that we obtained have a maximum value that is greater than 0 and a minimum value that is less than 0. Moreover, the mean of all vectors varied slightly between -0.08 and -0.007

while the standard variation ranged between 0.35 and 0.5.

If "Coef" is the feature vector of an image than the following quantization scheme converts it to its equivalent code-word:

· If Coef(i) >= 0 then Coef(i) = 1

· If Coef(i) < 0 then Coef(i) = 0

The next step is to compare two code-words to find out if

they represent the same person or not.

Test of statistical independence

This test enables the comparison of two iris patterns. This test is based on the idea that the greater the Hamming distance between two feature vectors, the greater the difference between them. Two similar irises will fail this test since the distance between them will be small. In fact, any two different irises are statistically "guaranteed" to pass this test as already proven. The Hamming distance (HD) between two Boolean vectors is defined as follows:

$$HD = \frac{1}{N}\sum_{j=1}^{N} C_A(j) \oplus C_B(j)$$

where, C_A and C_B are the coefficients of two iris images and N is the size of the feature vector (in our case N = 702). The Å is the known Boolean operator that gives a binary 1 if the bits at position j in C_A and C_B are different and 0 if they are similar.
John Daugman, the pioneer in iris recognition conducted his tests on a very large number of iris patterns (up to 3 million iris images) and deduced that the maximum Hamming distance that exists between two irises belonging to the same person is 0.32 . Since we were not able to access any large eyes database and were only able to collect 60 images, we adopted this threshold and used it. Thus, when comparing two iris images, their corresponding binary feature vectors are passed to a function responsible of calculating the Hamming distance between the two. The decision of whether these two images belong to the same person depends upon the following result:

· If HD <= 0.32 decide that it is same person
· If HD > 0.32 decide that it is different person
(or left and right eyes of the same person).

Matching

This part is the last step of the improved method. The aim is to match iris meaning the code. The matching process is to get the similarity and dissimilarity value. Differ from Daugman that only use one matching algorithm, we used two algorithm to improve the matching result. We used Hamming and Euclidean Distance Algorithm.
1) Dissimilarity:

Hamming Distance

For binary strings a and b the Hamming distance is equal to the number of ones in a XOR b[7]. The equation of Hamming Distance is defined by:

$$HD = \frac{1}{2{,}408}\sum_{j=1}^{2{,}408} A_j (XOR) B_j$$

Where A is the first image matrices and B is the second
image matrices.

Euclidean Distance

The Euclidean distance or Euclidean metric is the .ordinary
. distance between two points that one would measure with a ruler, which can be proven by repeated application of the Pythagorean theorem[10]. The formula is
defined by:

$$p1(x_1,y_1) and p2(x_2,y_2) = \sqrt{((x_1 - x_2)^2 + (y_1 - y_2)^2)}$$

where p1(x1;y1) is first image with x and y coordinates
of pixel. where p2(x2;y2) is second image with x and y coordinates of pixel. To get the distance value is by calculating the deviation between their coordinates. After that, we square the root of result. Remember that, we calculate the pixel value that located in the same coordinate of its.

2) Similarity: In similarity, the idea is same like dissimilarity.
We calculate the distance from two image that we want to match. However, we can use only HD or Euclidean to match it. But, we want to know more about the distance specially in similarity. Consider to the basic idea in matching images, we should calculate its pixel. Mathematically, the formula can be written as following:

$$S_i = \frac{\sum_{i=1}^{n} P_i + ((C_{h,i}) x (I_{h,i}))}{\sqrt{\sum_{i=1}^{n}((Q_i + (I_{h,i})^2) x (Q_i + (C_{h,i})^2)}}$$

Result and Performance

We tested our project on 60 pictures, using a Pentium IV processor, and we obtained an average of correct recognition of 93%, with an average computing time of 31s. Table 1 gives the efficiency of each part of the system. The main reason of the failures we encountered is due to the quality of the pictures. Some of these problems are bad lighting, occlusion by eyelids, noises or inappropriate eye positioning.

Graphics User Interface

To easily manipulate the images in our database we built an interface that allows the user to choose between different options. The first one is to select two images to compare. The second allows the verification of the correspondence between the name entered and a chosen eye image. The third option is to identify the person through his/her eye. The iris recognition software that we implemented (Figure 7) is used to secure these three options. The flow chart in Figure 8 shows in detail how the interface we built operates

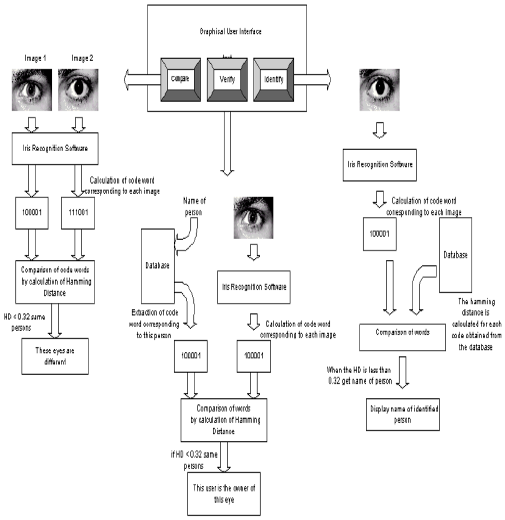

Figure. 8. Flow Chart Of Project

Conclusion

In this paper, we described a fast and effective real-time algorithm for localizing and segmenting the iris and pupil Boundaries of the eye from database images. Our approach detects the center and the boundaries quickly and reliably, even in the presence of eyelashes, under very low contrast interface and in the presence of excess illumination. This paper can enhance the performance of iris recognition system by using the canny edge detection and statistical features for iris recognition. In which we tested the comparison of two iris patterns by using Hamming distance. We have successfully developed this new Iris Recognition system capable of comparing two iris images. This identification system is quite simple requiring few components and effective enough to be integrated within security systems that require an identity check. Results have demonstrated 97% accuracy rate with a relatively rapid execution time. It is suggested that this algorithm can serve as an essential component for iris recognition applications. The experimental results show that the outputs of this paper are satisfactory. It will be better if more statistical features are used such as pixels correlation
in the iris area.

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