Recognition of IRIS for Person Identification

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Abstract

Iris recognition is a proven, accurate means to identify people. In this paper, it includes the preprocessing system, segmentation, feature extraction and recognition. Especially it focuses on image segmentation and statistical feature extraction for iris recognition process. The performance of iris recognition system highly depends on segmentation. For instance, even an effective feature extraction method would not be able to obtain useful information from an iris image that is not segmented properly. This paper presents a straightforward approach for segmenting the iris patterns. The used method determines an automated global threshold and the pupil center. Experiments are performed using iris images obtained from CASIA database. Institute of Automation, Chinese Academy of Sciences) and Mat lab application for its easy and efficient tools in image manipulation.

*Keywords***-iris recognition; segmentation; feature vector; edge detection

I. INTRODUCTION

Technology advancements create new opportunities to automate the biometrics authentication process and reduce hardware and software costs. Automating the biometrics process can speed authentication-processing times, increase the certainty that the right person is requesting authorization, and may, in some instances, strengthen authentication practices by using multi-factor techniques. These benefits also may allow for new and/or expanded business opportunities.

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 [1], [2]. 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. Experts assert that the iris is the most data rich part of the body. Iris recognition devices can use 260 degrees of freedom making it significantly more accurate than fingerprint recognition. The iris is the colored part of the eye at the front of the lobe.

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.

II. Aim and Scope of the Project

The aim of our project is to capture the eye image and performing segmentation process to get the iris and the same segmentation process is done for the data present in database and by using hamming distance we are able to say whether the person is authenticated or not.

A. THE HUMAN IRIS

The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. A front-on view of the iris is shown in Figure 2.1. The iris is perforated close to its centre by a circular aperture known as the pupil. The function of the iris is to control the amount of light entering through the pupil, and this is done by the sphincter and the dilator muscles, which adjust the size of the pupil. The average diameter of the iris is 12 mm, and the pupil size can vary from 10% to 80% of the iris diameter.

The iris consists of a number of layers, the lowest is the epithelium layer, which contains dense pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two iris muscles. The density of stromal pigmentation determines the colour of the iris. The externally visible surface of the multi-layered iris contains two zones, which often differ in colour. An outer ciliary zone and an inner pupillary zone, and these two zones are divided by the collarette – which appears as a zigzag pattern

B. BLOCK DIAGRAM

In the preprocessing stage, we transformed the images from RGB to gray level. Before performing iris pattern matching,
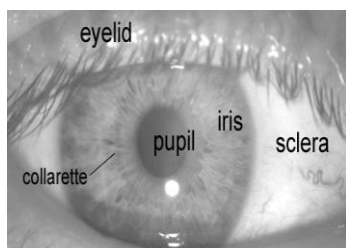
Figure 1: Eye Image

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. Enhancement in the original iris image can be reached by histogram equalization. We can use this equalization method with the default threshold value to obtain the gradient image.
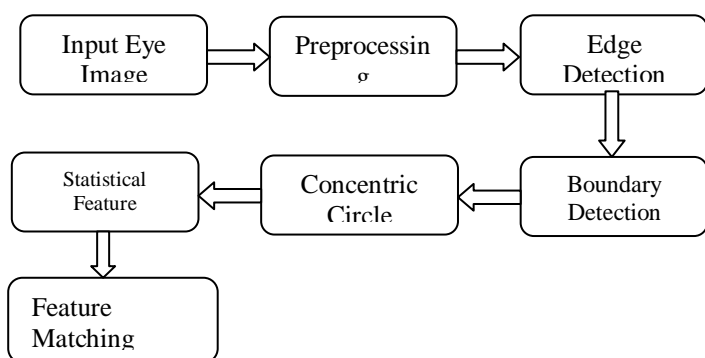

Figure 2: Block Diagram

The main stage deals with iris segmentation. This consists in localize the iris inner (pupillary) and outer (scleric) borders. There are two major strategies for iris segmentation: to use a rigid or deformable template of the iris or its boundary. In most cases, the boundary approach is very similar to the proposed by Wildes [9]: it begins by the construction of an edges map followed by the application of some geometric form fitting algorithm. Authors of [8] used this strategy together with a clustering process to increase the accuracy in noisy environments. The template-based strategies usually involve the maximization of some equation, as proposed by Duggan [7]: In order to compensate the varying size of the captured iris it is common to translate the segmented iris region, represented in the cartesian coordinate system, to a fixed length and dimensionless polar coordinate system. This is usually accomplished through a method similar to the Daugman's Rubber Sheet [8]. The next stage is the feature extraction. From this viewpoint, iris recognition approaches can be classified into three major categories: phase-based methods (e.g. [7]), zero crossing methods (e.g. [7]) and texture analysis based methods.

In the final stage it is made a comparison between iris signatures, producing a numeric dissimilarity value. If this value is higher than a threshold, the system outputs a"nonmatch", meaning that each signature belongs to different irises. Otherwise, the system outputs a"match", meaning that both signatures were extracted from images of the same iris. Different metrics like the Hamming, Euclidean, Weighted Euclidean or methods based on signal correlation can be applied.

III. EXISTING METHODS
A. PHYSICAL BIOMETRICS
The following highlights some of the more prevalent forms of physical biometrics in use today or under development.

i. Fingerprint Recognition
Fingerprint recognition is the best-known technique because law enforcement has used it for decades. Many fingerprint scanners are small and the technology is now being incorporated into keyboards, personal data assistants, and computer mice.

ii. Iris Recognition
Experts assert that the iris is the most data rich part of the body. Iris recognition devices can use 260 degrees of freedom making it significantly more accurate than fingerprint recognition. The iris is the colored part of the eye at the front of the lobe. Each iris is unique. A person's right and left iris are not the same. Iris recognition may not be effective in poorly lit or highly reflective lighting environments or when the user is wearing designer contact lenses or mirrored sunglasses.

iii. Retina Recognition
Retinal recognition is considered to be one of the most robust and accurate biometric identifiers. A retinal scan examines the small blood capillaries at the back of the eye using a low intensity light source. Similar to the iris, retina patterns are unique for each eye. User acceptance of retina recognition is lower than that of iris recognition because the retinal reader is less than one inch from the user's eye.

iv. Facial Recognition
Facial recognition determines the distances between such facial features as the nose, eyes, bone structure, mouth, and eyebrows. Recognition is usually not affected by moderate facial cosmetic surgery. The template file size is rather large; however, improvements in camera technology and communications speeds have helped to decrease authentication times. Facial recognition technology does not perform well under low or poor lighting conditions and identical twins may not be uniquely distinguishable.

v. Hand Geometry Recognition

Hand geometry recognition devices scan and measure the specific characteristics of a person's hand such as length of fingers and thumb, width, and depth. Hand geometry template size is rather small, allowing for faster data transmission and template matching.

B. BEHAVIORAL BIOMETRICS

A behavioral characteristic is a reflection of how an individual does something. Behavioral characteristics have the potential to change or become slightly altered over the course of an individual's life.

i. Voice Recognition

Voice recognition is the most widely known of the behavioral biometric technologies. Voice recognition measures and records three basic parameters of an individual's voice: pitch, dynamics and waveform. However, voices can change drastically due to smoking, stress, illness or maturation, resulting in higher error rates. Background-noise and microphone-quality can significantly affect systems performance.

ii. Handwriting Recognition

Handwriting and signature recognition analyzes an individual's signature. Handwriting recognition can be static or dynamic. Static recognition matches the presented signature to one on file (e.g., comparing check signature to signature card). This can be done either manually or electronically. Dynamic recognition evaluates the written signature and the process of writing it. Dynamic features analyzed can include writing speed and pen pressure, directions, stroke length and the points in time when the pen is lifted from the paper.

iii. Dynamic Keystroke Recognition

Dynamic keyboard recognition analyzes the way in which a person types on a keyboard. Two aspects are examined: dwell-time and flight-time. Dwell-time is the time a person holds down particular keys. Flight-time is the time between keypunches. Keystroke dynamics works better for touch-typists rather than hunt-and-peck typists. The lack of keyboard uniformity and industry standards for keyboards complicates software compatibility issues and reduces the effectiveness of this method.

IV. PROPOSED ALGORITHM

A. PREPROCESSING

In the preprocessing stage, we transformed the images from RGB to gray level. 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.

Enhancement in the original iris image can be reached by histogram equalization. We can use this equalization method with the default threshold value to obtain the gradient image.

B. SEGMENTATION

Segmentation process is the most important and difficult steps in the image processing system. It means the quality of image processing heavily depends on the quality of segmentation process.

In this process, we applied Sobel edge detector. By using this detector, we can easily see the gradient value. If global threshold value is used on that gradient image, the gradient values along the potential edge (Fig. 2) will be lost. In order to avoid that effect we can use local threshold in the area of interest. Gabor filtering is also a good solution to that problem as well as a preprocessing tool for quality edge detection stage [3] [4].
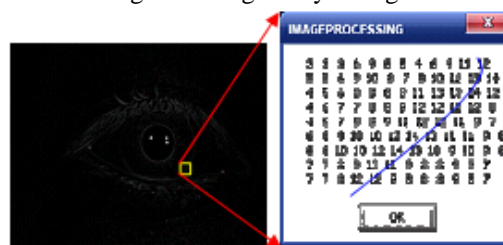

Figure 3: original eye image

Figure 4: Gradient image after sobel edge detector

C. FEATURE EXTRACTION

One of the most interesting aspects of the world is that it can be considered to be made up of patterns. A pattern is essentially an arrangement. It is characterized by the order of the elements of which it is made, rather than by the intrinsic nature of these elements. This definition summarizes our purpose in this part. In fact, this step is responsible of extracting the patterns of the iris taking into account the correlation between adjacent pixels.
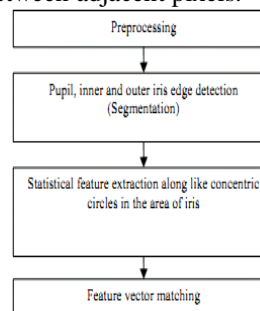

Figure 5: Iris recognition process

In this process we propose statistical feature extraction methods for iris recognition process. It can be viewed as the above procedures:-

D. STATISTICAL FEATURES EXTRACTION
After edge detection, we get inner and outer edges of iris as well as pupils area. Using the center of pupil and inner edge, we can draw various sizes of lines like concentric circles along which statistical features are computed [4] [6].
Following statistical features are considered in this paper for iris recognition process:-
(a) Mean
(b) Median
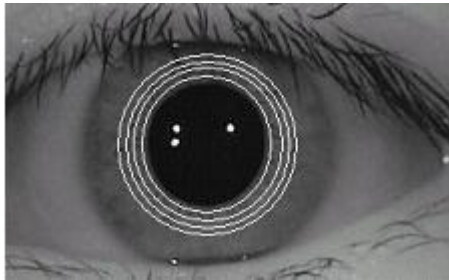(c) Mode
(d) Variance and
(e) Standard deviation of the circles

Figure 6: Features extraction along the circular shape on an iris

Mean

$$\overline{X^c} = \sum_{i=1}^{N^c} X_i^c, \ c = \overline{1,C}$$

$C -$ number of circles in the segmented iris,
$X_i^c -$ intensity (gradient) value of ith pixel of the cth circle,

Variance

$$S^{c^2} = \frac{1}{N^c - 1} \sum_{i=1}^{N^c} \left(X_i^c - \overline{X_i^c} \right)^2$$

Standard deviation

$$d = \sqrt{\frac{1}{N^c - 1} \sum_{i=1}^{N^c} \left(X_i^c - \overline{X_i^c} \right)^2}$$

$N^c -$ number of pixels along the cth circle
These extracted features are stored in the database for identification process. Using these features; an image can be viewed as a feature vector $\overline{F_c}, C = \overline{1,C}$ of that image having desired number of circles.

$$\overline{F_c} = (X^c, M^c, S^c, d^c, ...), c = \overline{1,C}$$

Where
C = number of circles in the segmented iris
X^c = mean of the cth circle
M^c = mode of the cth circle
S^c= variance of the cth circle
D^c= standard deviation of the cth circle

E. MATCHING
A pattern matching process is required after extraction process of the iris pattern. In this recognition process, distance between the feature vectors of two iris images can be computed by

$$D(F_c, F_c^i), i = \overline{1,N}$$

Where
F_c= feature of input pattern
F_c^i= feature of ith pattern from the database
N = number of patterns in the database
In this process, there is the most similar pattern which is assigned as d_{i*}, to the database pattern. d_{i*} is the pattern which has the minimum distance value of D_{i*}

$$D_{i*} = min \, D_i(F_c, F_c^i), i = \overline{1,N}$$

By comparing the feature vectors using some methods such as:
a. Hamming distance
b. Root-mean square
c. Entropy
d. Neural network
We determine finally whether two irises are similar, our results show that our system is quite effective. 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. The $\oplus$ is the known Boolean operator that gives a binary 1 if the bits at position j in C_A and C_A are different and 0 if they are similar. We can also calculate the distance D_{i*}, between input iris pattern and database pattern by using root-mean square method,

$$D_{i*} = \sum_{i=1}^{N} (X_c - X_c^i)^2$$

In which we can find out the minimum distance value of D_{i*}, so we can assign that the pattern with this minimum value is the most similar pattern to the database pattern. The Shannon entropy measure

$$S = -\sum_{j=1}^{n} P_j \, log_2 \, P_j$$

For P_j the probability of each of the n states and with

$$\sum_{j=1}^{n} P_j = 1$$

is maximum when for all j,

$$P_j = \frac{1}{n}$$

By using this equation, we can also get the minimum distance value. Similarly, this minimum distance

determines the input pattern which is the most similar to the database pattern.

V. CONCLUSION

This paper can enhance the performance of iris recognition system by using the statistical features. 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. Judging by the clear distinctiveness of the iris patterns we can expect iris recognition systems to become the leading technology in identity verification. 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. Using Neural network technology can make the recognition process get more accuracy [5].

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