An Improved Iris Recognition Method Based on Gray Surface Matching

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Abstract—A new method is proposed to overcome illumination intensity difference influences the recognition result which occurs during collecting session in this paper. The problem is not effective solved in original algorithm. This algorithm proposes to match after moving two matching feature surfaces to one equivalence gray plane. It also uses the theory of gray surface matching based on feature analysis but another distance is considered for reducing calculation quantity. Firstly, it calculates the gray difference of two pixels which comes from doing subtraction between two different surfaces and gets the gray difference surface. Secondly, it computes the square of the gray difference surface and considers this square as the distance between the two surfaces. At last, it compares the result with a given threshold to implement iris recognition. Simulation and experimental results are shown to illustrate this method performance for both correct recognition rate and the whole recognition time.

Keywords- equivalence gray plane; gray surface; iris recognition; illumination intensity

I. INTRODUCTION

In recent years, as information technology and the growing security needs, the technology based on biometric identification got a rapid development. Due to its high reliability, non-contact and some other advantages, iris recognition technology has become a hot topic in the field of biometric identification.

There are three algorithms can be regarded as the representative in traditional iris recognition algorithms[1]-[5]. In their iris recognition technologies, they usually use various math methods to extract the eigenvalue of original iris images, and compare them with the eigenvalue of the iris images registered in advance. Then they determine whether the two irises come from the same eye according to the degree of matching result.

This paper improves the recognition rate upon the original algorithm which based on surface matching[6]. The main idea of the algorithm is: imagine the iris region is a gray surface in the three-dimensional(3D) space(the position and gray value of the iris), when two irises come from the same eye, because they have the same veins, the two gray surfaces should have the same or similar shape. While when they come from different eyes, they have different shape. So we can determine whether the two irises come from the same eye or not, if we are able to detect the differences about the gray surface in the 3D space. In the original method, there is no effective solution about that the illumination intensity is not exactly the same during collecting the iris. Therefore, the identification effect is not very well. In order to reduce this factor influences recognition result, this paper proposed to move two matching surfaces to one equivalence gray plane.

Because the matching operation is done on iris gray image, it doesn't have to extract the eigenvalue. The whole iris area, instead of a group of numbers, takes part in matching process. What's more, it's very difficult to imitate live iris image, so the notable advantage of this method is to improve the system's safety and reduce computation.

II. IRIS IMAGE PREPROCESSING

The iris image preprocessing mainly includes the location of the iris region and the translation to normalized iris image. In order to emphasize the veins of iris image which is useful for the matching process, it enhances the normalized image. And because the original iris images we obtained are not only including iris, but also have some information of pupil, eyelid, eyelash, white etc, which is useless, as shown in Fig.1. And the location, size and area of the iris in the whole image are different. So the iris image must be preprocessed before distilling the iris area. Firstly, the iris should be segmented, then compensate the difference caused by parallel moving, size difference etc. In the end, normalize the iris image.

Figure 1. Original iris image

Figure 2. Image of iris localization
This location method used in this paper integrated the character of eyes. And it uses the principle of a circle can be determined by three points which are not on a common line to decide the inner and outer edge of the iris. The algorithm firstly located a random point in the pupil, and then uses an edge detection template to search the three different points to detect inner edge.

As the gray value of the pupil is the smallest, it uses the sum template to find the minimum point which is in the pupil. And the gray value of the boundary between the inner and outer edge changes a lot. So after finding the point in the pupil, it searches three maximum grads along three different directions. Then it uses the three points to locate the iris, as shown in Fig. 2.

In order to achieve accurate matching between two irises, it needs to normalize the two images. It projects the iris region to a polar coordinates[7]. The mapped relation is:

\[ x(r, \theta) = (1 - r) x_p + r x_q(\theta) \]  (1)

\[ y(r, \theta) = (1 - r) y_p + r y_q(\theta) \]  (2)

\[ p = (x_p, y_p) \] and \[ q = (x_q, y_q) \] are the center of the pupil. There may be some shelters from the eyelash and eyelid. So we need to choose of the normalized region to reduce this factor influences the recognition result. In this paper [−210°,30°] area was chosen. The normalized result was shown in Fig. 3.

It uses histogram equalization to enhance the iris image, as shown in Fig. 4.

III. FEATURE SURFACE ANALYSIS

The wave of the surface in 3D gray space is corresponding with the iris veins. It uses the level direction of the image as X axis, vertical direction as Y axis, and the gray value as Z axis to create Cartesian coordinate system. And each pixel of the iris image can described in this system as shown in Fig. 5. And this surface is called feature surface in this paper.

If the two feature surfaces have the same or similar shape, the location in the 3D gray space must be overlapped or paralleled. The difference of the two images can be measured by the distance of the two surfaces.

IV. MATCHING

Due to the illumination differences during collecting session, the veins of the iris surface will also change. This kind of difference can be represented as the average gray value is different. According to the experiment results, this difference will influence the match result greatly. This algorithm proposes to move two matching feature surfaces to one equivalence gray plane before matching, which will reduce the influence of the recognition result.

It is supposed that the feature surface of enter iris is P, the other that we have saved is Q. We can find both of the feature surface is the same or a little different if P and Q are the same irises. If P and Q are coming form different iris, the wave of the feature surface is different from each other completely. The difference of space surface in shape can measure by one of distance between them in mathematics. In this paper, the distance is using in this way. Firstly, doing subtraction between P and Q and gets the difference surface. Then it calculates square of the difference value and considers the square as the distance between P and Q. To compare with original algorithm, this method can reduce computing quantity, enhance difference between the different feature surfaces, and solve the problem of feature surface changes as the illumination intensity difference when we collect the iris effectively.

After above analysis, if P and Q are the same iris can be below three cases:

1) Doing subtraction between P and Q, the surface is the same if the value of difference surface is zero.
2) After P minuses Q, the surface is the same if the value of difference surface is a constant. (May be one of feature surface’s illumination intensity is more than another one).
3) After P minuses Q, it is a ruleless surface (May be the illumination intensity is different between them and is volatile). Then it should consider the degree of the gray surface changing. If the degree of the gray surface changing is a little, P and Q are coming from same iris, otherwise, they come from different iris.

This matching method can implement in the following two steps:

1) It computes the gray difference of two pixels which are at the same position from two different images. It can be described as expressions (3). \( R_{ij} \) is the gray difference between P and Q.

\[ R_{ij} = P_{ij} - Q_{ij} \]  (3)
2) It calculates the square of \( R_{ij} \) as expressions (4). \( W \) and \( H \) are the width and height of the image.

\[
Y = \frac{1}{W \times H} \sum_{i=0}^{W-1} \sum_{j=0}^{H-1} R_{ij}^2
\]

(4)

To compare \( Y \) with a threshold, we can distinguish if \( P \) and \( Q \) is the same iris.

As the eyes or head of the volunteers’ rotating when collecting iris, the veins position of two irises may not corresponding. In the other word, the two iris gray surfaces are not in the same reference frame. So \( Y \) will increase although \( P \) and \( Q \) are the same irises. In order to make \( P \) and \( Q \) in the same reference frame, it needs to rotate an angle to the two iris images. If the two iris images are the same, there must be a position that can make the two gray surfaces achieve the best matching. To solve the problem of rotating influence to iris recognition, it needs to make a translation to normalized iris image after compute \( Y \) (Certainly, maybe \( P \) and \( Q \) are not the same iris or they are the same iris but not in the same reference frame). And it stops when it searches the minimum of \( Y \).

V. EXPERIMENTAL RESULTS AND ANALYSIS

The CASIA iris database (Version 1.0) of Institute of Automation Chinese Academy of Sciences was used in this paper. It has 756 images, include 108 different types of iris swatch from 80 persons. Each kind of iris image has 7 images which were collected in two sessions and their resolution is 320 by 280 pixels. 8046 matching experiments were done to the 108 different kinds of iris image after compute \( Y \) (Certainly, maybe \( P \) and \( Q \) are not the same iris or they are the same iris but not in the same reference frame). And it stops when it searches the minimum of \( Y \).

All the experiments are implemented in Visual C++ 6.0. The CPU of computer is P4 2.0 GHz, the operating system is Windows XP Professional.

VI. CONCLUSION

A new method is proposed to solve illumination intensity difference which will influence the recognition result in this paper. This algorithm through moving two matching feature surfaces to one equivalence gray plane to overcome this factor influences the recognition result. In order to reduce calculation quantity and enhance the difference between two different kinds iris, this paper computes the square of gray difference surface. The result demonstrates this algorithm is better than original algorithm in correct recognition rate and consumed time.

ACKNOWLEDGMENT

The authors are grateful to Institute of Automation Chinese Academy of Sciences for supplying the iris database; and to Scientific Research Plan Projects Of Shaanxi Provincial Department Of Education NO.08JK356 for supporting this study.

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