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IRIS VERIFICATION BASED ON FRACTIONAL FOURIER TRANSFORM

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Abstract:

Iris verification is one of the biometrics verification technologies. This paper proposes a new iris verification method based on fractional Fourier transform. Through comparing two irises' Fractional Fourier Transform, we can distinguish the people whether they are the same person. At last, we introduce some applications of iris verification used for security in E-commerce.

Keywords:
Biometrics; Iris verification; Fractional Fourier transform

1 Introduction

Nowadays, one of the main threats that IT systems and security environments meet is the intrude event. People usually use passwords, secret codes and/or identification card of tokens to solve this issue. But there are also shortcomings, for passwords are easy to be forgotten or confused and keys are easy to be lost or stolen. Many intruders take use of those shortcomings to attack the system by robbing, copying or simulating. Therefore, people want to seek new authentication tool to solve those problems. Biometric is the most secure and convenient authentication technology. The physical character of body cannot be borrowed, stolen, or forgotten, and forging one is practically impossible. Common physical biometrics includes fingerprints, hand or palm geometry, retina, iris and facial characteristics. Behavioral characters include signature, voice (which also has a physical component), keystroke pattern, and gait. Today, all above biometric technologies have been used. Each of them has its own strengths to make it more appropriate than others for certain types of applications. Among all of these techniques, iris verification is the most promising for high security environments and it is noninvasive for people.

The biometric identification problem can be divided into two respects. One is recognition, the other is verification. Recognition means one-to-many, namely, finding a person's identity from large database. Verification means one-to-one. It refers to confirm or deny a person's claimed identity.

The possibility that the iris of the eye might be used as a kind of optical fingerprint for personal identification was suggested originally by ophthalmologists. During the course of examining large number eyes, ophthalmologists and anatomists have noted that the detailed pattern of an iris, even the left and the right of a single person, seems to be highly distinctive. Further, in cases with repeated observations, the patterns seem to vary little, at least in the past childhood. The probability that two irises will produce the same mathematical code is approximately one in ten to 78^{th} power, while the population of the earth is approximately ten to the tenth power. Due to the complex interplay of the iris' muscles, the diameter of the pupil is in a constant state of small oscillation. Potentially, this movement could be monitored to make sure that a live specimen is being evaluated, to prevent impersonation. At present, only two systems are proposed to this research area. Both John Daugman's and Richard P wildes's system have a fully picture on iris acquisition, iris localization, verification and/or identification [1,2]. Besides Boles et al. used wavelet transform for iris identification [3]. In this paper, we propose a new method of iris verification based on fractional Fourier transform. The numerical simulations have verified the validity of verification of the iris of human eye, namely indirectly by means of a computer analysis of fractional Fourier transform of two iris images.

2 Fractional Fourier Transform

The two-dimensional fractional Fourier transform of a function $f(x, y)$ with a separable kernel can be defined as [4,5]:

$$F^{\alpha_x,\alpha_y}[f(x,y)](u,v) = \int\int_{-\infty}^{\infty} H_{\alpha_x,\alpha_y}(x,y;u,v) f(x,y)dxdy \quad (1)$$

with the kernel

$$H_{\alpha_x,\alpha_y}(x,y;u,v) = H_{\alpha_x}(x,u)H_{\alpha_y}(y,v) \quad (2)$$

where

$$H_{\alpha_x}(x,u) = \begin{cases} A_{\phi_x} \exp\{i\pi(x^2\cot\phi_x - 2x\pi\csc\phi_x \\ +u^2\cot\phi_x)] & \text{If } \alpha_x \neq n\pi \\ \delta(x-u) & \text{If } \alpha_x = 2n\pi \\ \delta(x+u) & \text{If } \alpha_x = (2n+1)\pi \end{cases} \quad (3)$$

and

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$$A_{\phi_x} = \frac{\exp[-i(\pi \operatorname{sgn}(\phi_x)/4 - \phi_x/2]}{\sqrt{|\sin \phi_x|}} \quad (4)$$

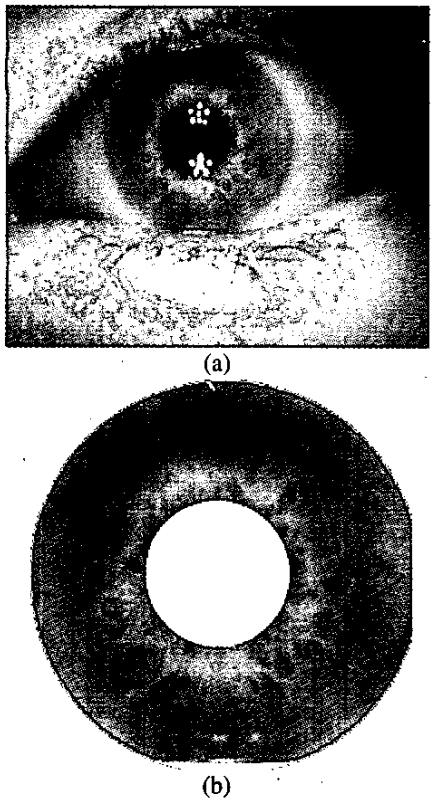
where $\phi_x = \alpha_x \pi/2$ is the angle corresponding to the transform order along the x-axis. The kernel along y-axis $H_{\alpha_y}(y,v)$ has the same form by simply substituting y for x and v for u, respectively.

For simplicity, we only consider the case of $\alpha_x = \alpha_y = \alpha$.

3 Iris Verification

3.1 Preprocess of the iris image

All the pictures in our test are captured by using a high-resolution photo camera. The original size of eye image is 768×568 pixels .The preprocess of the iris image can be finished in two steps. The first step is to localize the iris boundary. Thus the iris part can be extracted from the whole image. Then the size of the image will be scaled to have the same constant diameter. After normalization, a 512×512 pixel image is obtained. Through image acquisition, we suppose the center of the pupil is also the center of the iris, thus we can correct the error of rotation and shift. The eyelid occlusion and corneal specular reflection must be considered during the image acquisition.



(a)

(b)

Fig.1. (a) eye image (b) iris image

Fig.1 shows the pictures of one eye and its iris images.

3.2 Measure of similarity and experiment result

In this paper 150 iris samples are used to test our method. These samples are obtained from 50 persons, that is to say, every person has been taken three pictures from the same eye. To every person, one of his iris image is taken to have the fractional Fourier transform with the fractional order α is 0.5, then the other iris image is also taken to have the same fractional order transform. Fig.2 shows the fractional Fourier transform of the iris in Fig.1

To two iris images, we use similarity r to classify. The similarity r is defined by the relation

$$r = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}[a^m(i,j) - a^n(i,j)]^2}{N \times N} \quad (5)$$

Here $a^m(i,j)$ and $a^n(i,j)$ are the values of elements of characteristic matrices which belong to mth and nth iris in the database under consideration. The measure of similarity r is a real value between (0,1). The theoretical minimum value r=0 corresponds to the ideal case that the two irises come from the same one, whereas the theoretical maximum value r=1 corresponds the case that two iris come from the different one. N is the size of the picture. Through using formula (5), the irises are classified whether they come from the same sample or not.

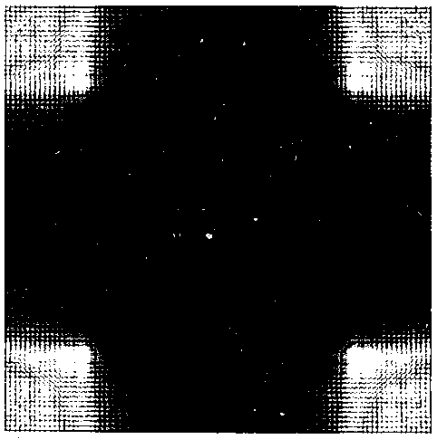


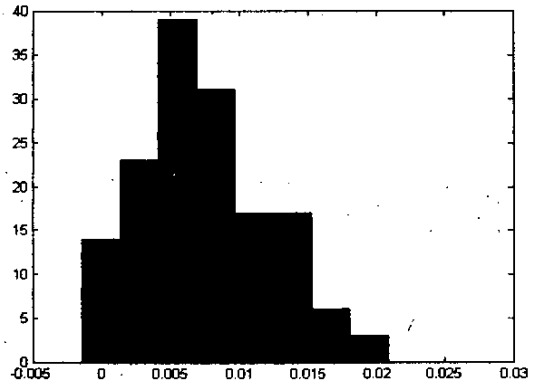
Fig.2. the fractional Fourier transform of the iris

Table.1 is the similarity r of the top 10 persons from the whole 50 persons iris database. The diagonal values in the table represent the same iris comparison, while the other values represent the different iris comparison. From the value we can know that the similarity between the same irises are far lower than that of the different irises.

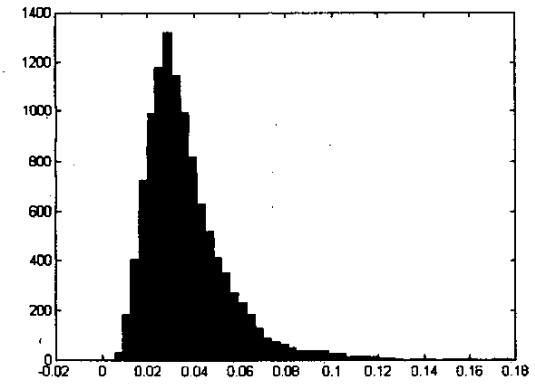
Two obtained particular histograms corresponding to the comparison of the same and the different irises under consideration are illustrated in Fig.3. The histograms in Fig.3 (a) correspond to 150 different pairs of the same irises

from the given 50 different triplets. Every triplet gives namely three comparative pairs of the same samples according to the law of combination of the second class from three elements without repetition. In Fig.3 (b) the number of different pairs of the different irises for 150 samples is equal to $C_2(150)-50C_2(3)=11025$.

After selecting the suitable similarity value r_c, we can judge whether the irises are the same or not. When the similarity r is smaller than r_c ($r<r_c$), it corresponds to the comparison of the same sample. When $r>r_c$, it means that the two irises are not the same iris.



(a)



(b)

Fig.3. Histograms represent the absolute frequency of the measures of iris similarity r for (a) the same irises and (b) the different irises.

In our test, let $r_c=0.01$, the false acceptance rate (the probability of identifying an intruder as an enrolled user) is 0.26%, while the false rejection rate (the probability of rejecting an enrolled user as an intruder) is 1.79% [6].

At moment all the method of iris verification or identification use the fixed entropy value to classify the same or different irises. If the entropy value can be designed to be active, then the effect of verification can be modified to be better. In the further research work we will study this aspect.

4 Application Of Iris Verification For E-Commerce

E-commerce developers are exploring the use of biometrics and smart cards to more accurately verify a trading party's identity. For example, many banks are interested in this combination to better authenticate customers and ensure non-repudiation of online banking, trading, and purchasing transactions.

Banks may embrace iris verification technology from various aspects. Automated Teller Machines (ATMs) and transactions at the point of sale, telephone banking, Internet banking and many other banking applications are vulnerable to fraud and can be secured by iris verification.

Moorestown, NJ. - Iridian Technologies, Inc., provider of authentication technology and developers of iris recognition technology announced the launch of its authentication server. It is a software product that enables businesses to be easily integrated by iris recognition technology into their computer networks to protect and secure a variety of transaction-based applications while running large user databases [7]. The authentication server is a software program that accepts an iris image and digitizes it into a template known as an iris code. The server then compares it to the iris code records held in a database and provides output data as a result of the matching function, in the form of an acceptance or rejection. Two of the server's primary components are a processing engine that enrolls and matches iris codes in real time (shown in Fig.4), and a data component that stores iris code records and information uniquely associated with each code. Potential applications are password and privilege management, and client/server and web applications. It eliminates the need for passwords and/or token devices; certificates - like document signing; and solutions for pending HIPAA regulations such as

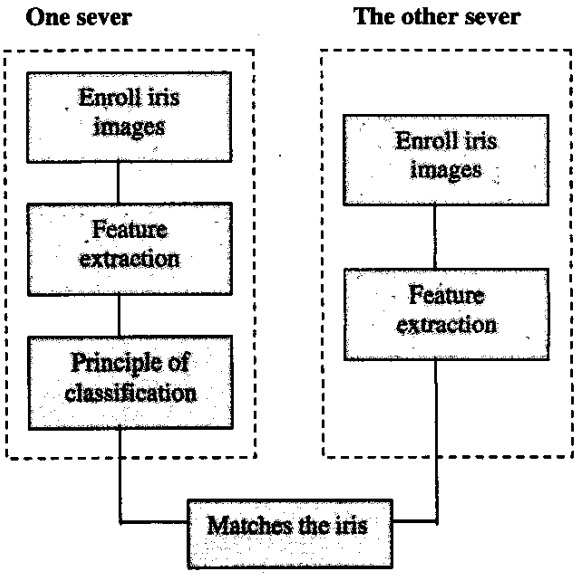


Fig.4. iris verification scheme

access to medical records, billings, drug dispensing, and prescription fulfillment. The authentication server canoperate in verification or identification mode, providing one-to-one and one-to-many exhaustive search capabilities to authenticate users in less than three seconds. Iris code records are in a database. Once enrolled, records can be modified or deleted by authorized network administrators. The database records all transactions in the audit table and features a number of built-in security measures.

5 Conclusions

In recent years, Security in E-commerce becomes more and more important, people do much efforts to use new method and new technology for the security of E-commerce system, among them biometrics is the best selection. All kinds of biometrics are used in many aspects of the commerce. Of all the biometrics technology, iris verification has high degree of accurate. In order to recognize the person, this paper presents a new method using fractional Fourier transform to analyze the iris texture. Numerical simulations have verified its validity. This method have good results of verification. Finally we simply introduce the application of iris verification used in E-Commerce.

With the rapid progress of computing and networking technology, we can foresee that the application of iris verification will become widely used in many fields of the society in the future.

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Table.1. similarity r of the 10 samples of the irises

	1	2	3	4	5	6	7	8	9	10
I	**0.0075**	0.0287	0.0104	0.0544	0.0265	0.0469	0.0228	0.0261	0.0409	0.0302
II	0.0159	**0.0050**	0.0268	0.0371	0.0286	0.0204	0.0193	0.0239	0.0250	0.0356
III	0.0194	0.0395	**0.0088**	0.0606	0.0239	0.0559	0.0240	0.0230	0.0485	0.0263
IV	0.0385	0.0377	0.0493	**0.0102**	0.0543	0.0298	0.0314	0.0345	0.0217	0.0626
V	0.0248	0.0352	0.0268	0.0571	**0.0054**	0.0461	0.0212	0.0127	0.0468	0.0096
VI	0.0343	0.0171	0.0507	0.0291	0.0483	**0.0068**	0.0243	0.0315	0.0303	0.0508
VII	0.0193	0.0255	0.0202	0.0270	0.0241	0.0307	**0.0077**	0.0119	0.0194	0.0308
VIII	0.0285	0.0379	0.0362	0.0453	0.0152	0.043	0.0203	**0.0119**	0.0382	0.0169
IX	0.0346	0.0236	0.0506	0.0160	0.0486	0.0251	0.0238	0.0272	**0.0034**	0.0598
X	0.0286	0.0408	0.0311	0.0725	0.0112	0.0538	0.0292	0.0210	0.0610	**0.0083**