Simple Identification Process Using Vein Pattern

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Abstract

In recent years biometrics security technology, which certify an individual with human characteristics, attracts more and more interest. In this study, we pay attention to vein pattern certification technology. We take photos of a vein pattern of forefinger by a transmitted near-infrared light method with a near-infrared light camera, convert them to grayscale images, emphasize the vein part, and get normalized images. In addition, we propose some algorithms to compare two images. There are some problems that lower the accuracy of recognition. One of the most important problems is to adjust the location of the two images. We show some experimental results as bases to solve this problem.

Introduction

People's interest in security for personal information is rising in recent years. Password, using memory and knowledge, etc. has been used as the former tool to protect security. While it is said that that safety and a certainty are necessary, living body authentication system is expected to realize them. Living body authentication utilize many parts of our body such as fingerprint, countenances, handwriting, irises, retinas, veins, voiceprint, and DNA. Especially, the identity authentication technology based on vein recognition has been more widely utilized in place of conventional password in various places such as automated teller machine (ATM).

Purpose

This study attempts to manufacture the finger vein authentication system with higher precision at lower cost. First, with attention to a vein pattern authentication technology, we manufacture near-infrared LED lighting, and capture veins with a CCD camera. Then, we construct authentication system by analyzing the extracted pictures of veins.

Vein certification

The vein works to return the blood including an unnecessary thing such as carbon dioxide or the waste material to the heart. Since the red blood cell of veins shows a characteristic to absorb specific near-infrared light, we can extract the image of the vein pattern. Even if the size of a finger changes by growth, the vein pattern itself remain unchanged. Moreover the vein patterns are different between twins. The vein patterns differ form person to person and it is hard to be imitated because it is a physical information, so it can be used for personal identification.

Vein pattern recognition

Outline of vein pattern recognition

A certification method to perform the person himself certification by a palm and the vein pattern of the finger-tip is the vein certification. The vein certification needs a reading device of palm size photographing with infrared rays, and the user has only to shade this with a hand without the device.

Compared to fingerprints, the information of vein is more difficult to copy because the veins run inside the body. In addition, we can get the stable, high certification rate in comparison with the other certification such as a face and handwriting, the voiceprint because the oscillation width of the condition is small.

In addition, by the vein certification, I collate a vein pattern with a registered pattern and confirm the person himself.

Features of vein authentication technology

1. Since it is an internal physical information, it is more difficult to counterfeit than other biometrics (fingerprint, face, irises, etc.), and thus reliability is high.
2. Because the penetration light is used to get the vein image of the finger, the influence such as dust and dirt is little.
3. The contact part of the tip of a finger is little, and user's psychological sense of resistance is little.
4. The vein pattern of a finger can be easily memorized to IC card.
5. The attestation speed and the attestation accuracy are high.

Experimental method

About near-infrared light

It had been said that the living body is hard to penetrate light until the transmittance of the near-infrared light of wavelength 700-1200nm turned out to be high. The light of this wavelength area penetrates the biotissue such as a muscle and the fat of the human body, but is absorbed by pigments such as the hemoglobin or melanin in blood.

Reduction hemoglobin streams down a vein and is the hemoglobin which lost oxygen. Oxidation hemoglobin and reduction hemoglobin have different absorption coefficients. Permeability continues being high, and, for near-infrared light, the reduction hemoglobin of blood was understood that it made the vein pattern visible by absorption (Fig. 1).

Making a sample of the near-infrared light illumination

The materials which we used to make a panel of near-infrared light this time are as follows;

Universal base (4.7 cm * 7.2 cm)	One,
Resistance (100Ω)	Five,
LED (950nm)	Five.

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Against a base, I installed LEDs and fix them with solder to make a light source as in Fig.2, which illuminate a finger from the back.

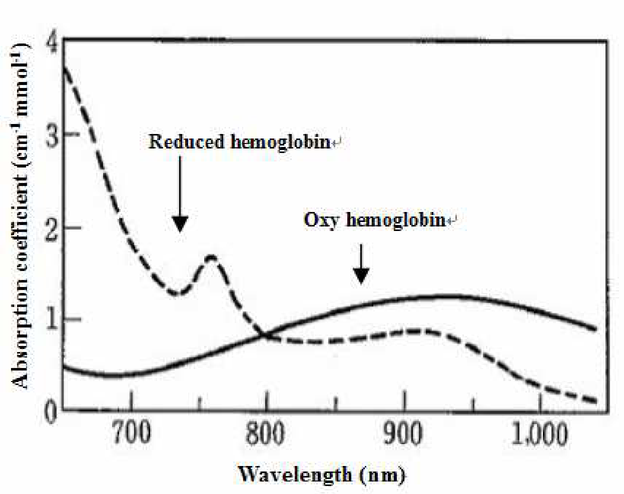


Figure 1. *Hemoglobin absorption spectrum*

Figure 2. *Light source*

Taking photos of the finger vein

Photographs of the vein image are taken by using a near-infrared light source placed at the back of the finger. The near-infrared light will penetrate the living tissue and transmit a light to the camera, thus the light part should be represented by white area in the captured images. On the other hand the light will be absorbed by the reduction hemoglobin, thus the blood vessel, especially the vein part should be represented by black area in the captured images. Note that the pattern of a vein in the deep part (for a center) of the finger and the bone will be represented by white, because they are deleted by dynamic scattering. This photographing schema is illustrated in Fig. 3.

We show the transmission image of the finger of an experimental subject which we photographed with this method in figure 4(a) and the transmission image of the finger of an experimental subject B in figure 4(b), respectively.

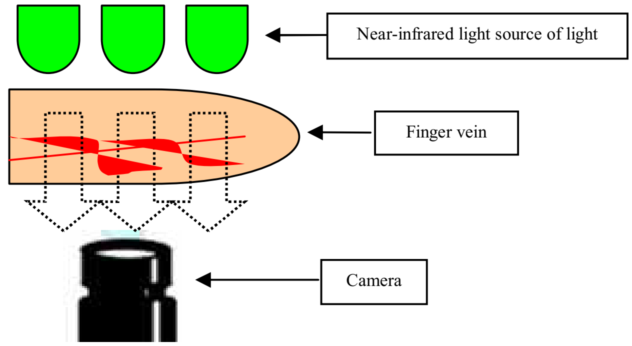
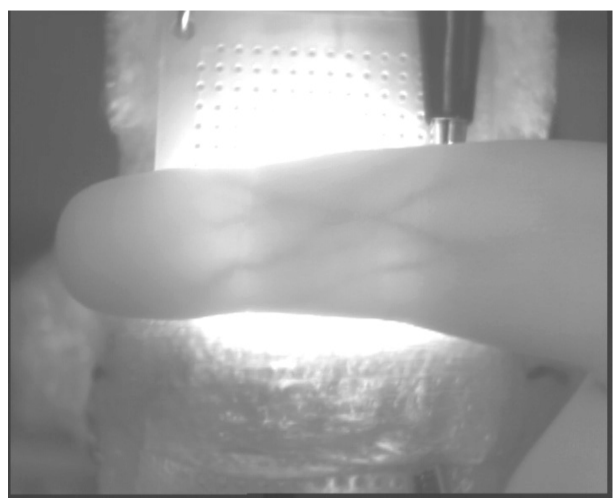


Figure 3. *Transmitted light method*

(a)



(b)

Figure 4. *The transmitted image of the finger (a) subject A (b) subject B*

Binarization

The emphasis process of a blood vessel picture is performed to pick the blood vessel pattern out from inscribed all sides-shaped with the biggest hand taken out (ROI: Region of Interesting) to analyze the feature of the vein pattern and pick out.

At first we perform a smoothing processing which smoothes a noise and takes the extreme value with the value of neighboring pixels. Next we move on to the binarization process. We apply a single threshold value to each pixel in the 256 continuous tone image, and the gray scale image is converted to a black-and-white image. The obtained image is easy to separate the blood vessel part and the background part.

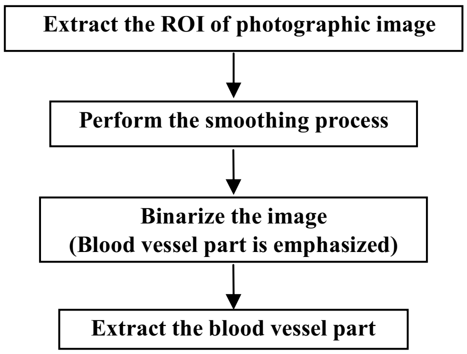


Figure 5. *Emphasis and the extraction of blood vessel parts*

Certification experiment

Preparation of sample photographs

We asked 20 people, from 17 to 50 of age, to be experimental subjects and took a photo of each person's forefinger. All the images are binarized by the same method as shown in Fig. 5. In the ROI extraction process, we used only a vein part and picked out 205 pixels in width and 141 pixels in length. We show two sample images of experimental subject A and B in Fig. 6(a) and (b), respectively.

(a)

(b)

Figure 6. *Sample images; (a) subject A (b) subject B*

Development of the software for pairwise comparison

We developed the software, with Microsoft Visual Basic, which could compare two images pixel by pixel and calculate the 'match rate'. The match rate is defined as a ratio of the number of the pixels having the same brightness value in common for the numbers of all the pixels, that is,

Match rate of image A and image B

$$= \frac{\#\text{pixels having the same position and value}}{\#\text{all the pixels of A (or B)}} \times 100 \qquad (1)$$

Pairwise comparison

Let $P_A(x, y)$ and $P_B(x, y)$ be two brightness values of pixels at the position of (x, y) of image A and B, respectively. Then we can say the number of pixels having the same position and the same value is $\left|\{(x, y) \mid P_A(x, y) = P_B(x, y)\}\right|$. However, we can not always extract the same position of a finger because the position of a finger changes every time we take photos. Therefore we define the modified match rate of image A and B as the following;

Modified match rate

$$= \frac{\max_{0 \le s,t \le 10} \left|\{(x, y) \mid P_A(x, y) = P_B(x + s, y + t)\}\right|}{\#\text{all the pixels of A (or B)}} \times 100 \qquad (2)$$

Result

The result is shown in Fig.7, where '-' indicates the maximum or minimum value and 'o' indicates the average value of the modified match rate.

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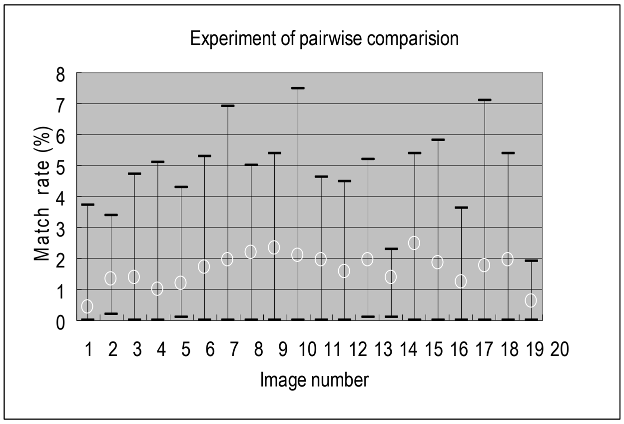

Figure 7. *Match rates of 20 images*

Discussion and future tasks

From the extracting process, comparatively good images were obtained, but it is necessary to normalize the brightness value of the image after taking photos, and to adjust quantity and dynamic scattering of the light source.

From the comparison experiment, many of the modified match rate are 0 and the average value is below 2.5%. We performed another experiment in which we compared two images of the same person taken on different days. The match rate was 6.7%, which is nearly the maximum rate of the pairwise comparison experiment. Thus we can say this method is effective to certificate a person.

As a future task, we want to determine the size and the position of the image to cut automatically. To realize this, we have to improve the image photographing conditions and to analyze the outline of a finger.

In addition, for a future problem, privacy protection becomes important. Biometrics authentication will bring the damage for a person's situation by any chance if the information flows out. Because I cannot easily change the living body information like a card or a password, scrupulous attention becomes necessary for both the side to use and the side to manage.

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