Extraction of Hand Vein Patterns in Image Profiles

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ABSTRACT: With the advent of information age, the security of information has become a crucial problem especially when it comes to secure identification system which is becoming increasingly rigorous. The traditional identification method has some shortcomings that cannot be overcome. However the authentication based on the biometric technology has some advantages such as not easily forgotten or lost, security performance, difficult to counterfeit or stolen, available anytime and anywhere. So it is more secure, reliable and valid. There are various biometric technologies. Among them hand vein recognition has the most potential for development of the biometric identification technology. In the proposed method an infrared camera is used to obtain the vein image. After pre-processing, a method known as maximum curvature is used in order to obtain the vein pattern. This method can extract the centre of vein lines constantly in spite of the fluctuations in the vein width and brightness.

***Keywords*: Biometric, Vein, Maximum Curvature**

1. INTRODUCTION

A wide variety of systems require reliable personal recognition schemes in order to either determine or confirm the identity of an individual requesting their services. The purpose of such schemes is to ensure that the provided services are accessed by no one except for an authorized person. Some of the examples of such applications include access to buildings securely, computer systems, laptops, and ATMs. In the absence of robustous personal recognition schemes, these systems are vulnerable to the attacks by an imposter.

A biometric system is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data and comparing this feature set against the template set in the database. Depending on the application context it may either operate in verification mode or identification mode. In the verification mode, the system validates a person‘s identity by comparing the captured biometric data with her own biometric template stored in the system database. In the identification mode, the system recognizes an individual by searching the templates of all users in the database for a match.

Biometric identification techniques use behavioral and physiological characteristics for person authentication. Vein is the one of these physiological characteristics. The vein biometric authentication system has attracted increasing attention in recent years. The pattern of veins is unique even in identical twins. Human palms have a broad and complicated vascular pattern and thus contain many kinds of features. The vein pattern biometric depends upon measurement of the vascular pattern made by the blood vessels on the back of the hand. Vein patterns are developed before birth and differ even between identical twins. Apart from their overall size which grows from birth to adulthood, these patterns persist throughout life.

It is one of the latest technologies in the field of biometrics. Its working principle is through exposing some specific body parts to infrared apparatus, the deoxygenated blood in the vein will absorb some of the infrared rays reducing its reflectivity and imaging. After capturing, the venous lines will be computed. The venous lines are unique. So they can be used to identify the individual. The vein recognition module only recognizes the venation for the flowing of the deoxygenated blood and it is difficult to copy. Therefore vein recognition technology has very high safety performance.

2. IMAGE ACQUISITION

To acquire the image a PC based acquisition system is developed. It consists of low cost CCD camera with good NIR sensitivity, IR LEDs socket, a glass to diffuse emitted IR rays evenly and an USB module to transfer the captured images to PC. Reflection based system is used.

In this method the person has to place his clenched fists in front of the camera in order to obtain the vein pattern.

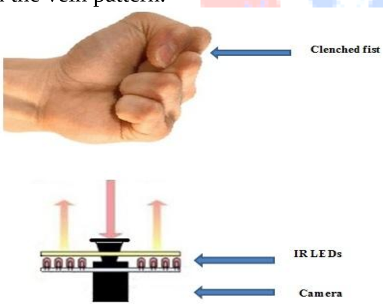

Figure 1: Image acquisition setup

3. PREPROCESSING

It includes the following stages:

3.1 Grayscale conversion

The color image is converted to a grayscale image. With this conversion the image size is decreased from 24 bits in each pixel to 8 bits in each black and white pixel. This conversion is practical due the ability to manipulate the image easily for further stages.

3.2 Contrast enhancement

The resulted images of dorsal hand veins are of low contrast. The spots on vein pattern are not distinguishable. Hence equalization of histogram is done in order to improve the appearance of vein pattern.

3.3 Global thresholding

Thresholding is the most basic form of image segmentation. There are two types of thresholding-local thresholding and global thresholding. In local thresholding, image is divided to sub-images and for each an individual sub-image threshold is determined. Where as in global thresholding technique, image is divided based on a single threshold value. Here Otsu's method is used as its moment preserving; entropy method yields consistent and good binary images with respect to uniformity and shape measures.

3.4 Morphological operations

Morphological processing is capable of removing small or extra particles on an image in a way that doesn't damage larger particles or the pictured shape.

3.5 Modifying the image

It involves image type conversion and colormap modification. In matlab, the intensity in each pixel is generally represented by unsigned 8 bit integer (uint8), which means that it can be assigned a value between 0 and 255. However it generates several problems to operate with unsigned integers. For this reason it is better to convert it into double representation temporally.

3.6 Resizing

Image resizing changes the size of the image without changing the number of pixels in the image. This increases the processing speed and also reduces in storage space. Another advantage is that the image comparison becomes easier.

3.7 Determining the ROI (Region of Interest)

In order to localize the hand region, masks were used. The masking values are shown in figure 2 and the upper and lower boundaries of the hand region were easily detected. The masking value was calculated in the Y direction for each X position. Based on the convolution value of the mask, boundary position was found out. The position at which the masking value became maximum, it was determined as the boundary position between the hand and the background in Y direction [2].

(a)

-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

(b)

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

Figure 2: Detection masks for the (a) upper and (b) lower hand regions. [2]

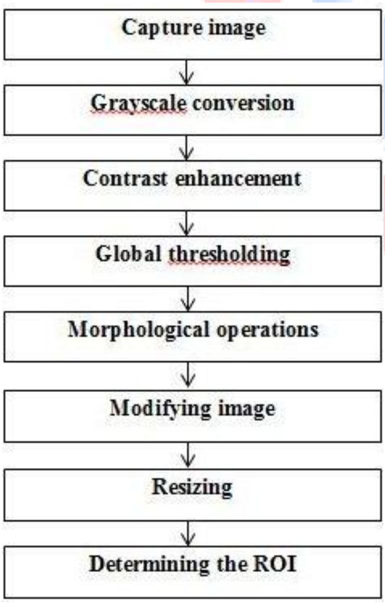

Figure 3: Preprocessing stages

4. FEATURE EXTRACTION

This method is based on calculating the curvatures in the cross sectional profiles of a vein image. In each profile, the locations of the maximum curvatures are found, and those maxima and their width are taken as the center and the width of the veins respectively.

It consists of 3 steps:

[Step 1] Extraction of the center positions of veins.
[Step 2] Connection of center positions.
[Step 3] Labelling of the image.

4.1 Extraction of the centre positions of veins

To extract the centerline of veins, cross-sectional profile of a hand vein image is checked. The cross-sectional profile of a vein looks like a dent because the vein is darker than the surrounding area.

F is a hand image and $F(x,y)$ is the intensity of pixel (x,y). We define $P_f(z)$ as a cross-sectional profile acquired from $F(x,y)$ at any direction and position where z is a position in a profile.The curvatutre , $\kappa(z)$, can be represented as

$$\kappa(z) = \frac{d^2 P_f(z) / dz^2}{\left(1 + \left(dP_f(z)/dz\right)^2\right)^{3/2}}$$

A profile is classified as concave or convex depending on whether $\kappa(z)$ is positive or negative. If $\kappa(z)$ is positive, the profile $P_f(z)$ is a dent (concave). First the local maximums of $\kappa(z)$ in each concave area are calculated. These points indicate the center positions of the veins. The positions of these points are defined as z_i' where $i = 0,1, \ldots N-1$ and N represents the number of local maximum points in the profile.

Next, scores are assigned to each center position. A score $S_{cr}(z)$ is defined as follows:

$$S_{cr}(z_i') = \kappa(z_i') \times W_r(i)$$

Where $W_r(i)$ is the width of the region where the curvature is positive and one of the z_i' is located (Figure 4).If $W_r(i)$ which represents the width of a vein is large, the probability that it is a vein is also large. Moreover, the curvature at the center of a vein is large when it appears clearly. Therefore, the width and the curvature of regions are considered in their scores.

Scores are assigned to a plane, V. That is,

$$V(x_i', y_i') = V(x_i', y_i') + S_{cr}(z_i')$$

Where (x_i', y_i') represents the points defined by $F(x_i', y_i') = T_{rs}(P_f(z_i'))$.

To obtain the vein pattern spreading in an entire image, profiles in all the directions are analyzed.

The directions used are horizontal, vertical, and the two oblique directions intersecting the horizontal and vertical at 45° . Thus, all the center positions of the veins are detected by calculating the local maximum curvatures.

The relationship among profile , curvature and probability score of veins is shown in figure 3.

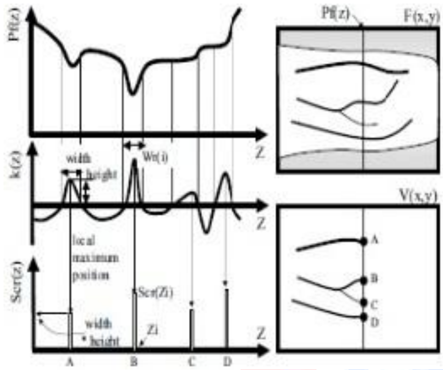

Figure 4: Relationship among profile, curvature and probability score of veins. [1]

4.2 Connection of vein centres

To connect the centres of veins and eliminate noise, the following filtering operation is conducted.

First, two neighbouring pixels on the right side and two neighbouring pixels on the left side of pixel (x,y) are checked. If (x,y) and the pixels on both sides have large values, a line is drawn horizontally. When (x,y) has a small value and the pixels on both sides have large values, a line is drawn with a gap at x,y . When (x,y) has a large value and the pixels on both sides of (x,y) have small values, a dot of noise is at (x,y) .

This operation can be represented as follows.

$$C_{d1}(x,y) = \min\{\max(V(x+1,y), V(x+2,y)) + \max(V(x-1,y), V(x-2,y))\}$$

The operation is applied to all pixels.

Secondly, this calculation is made for each of the pixels in all four directions in the same way, and C_{d2}, C_{d3}, C_{d4} are obtained. Finally, a final image $G\,(x,y)$ is obtained by selecting the maximum of $C_{d1}, C_{d2}, C_{d3}, C_{d4}$ for each pixel.

That is, $G = \max(C_{d1}, C_{d2}, C_{d3}, C_{d4})$.

4.3 Labelling the image

The vein pattern $G\,(x,y)$ is binarized by using a threshold. Pixels with values smaller than the threshold are labelled as parts of the background, and those with values greater than or equal to the threshold are labelled as parts of the vein region.

5. RESULTS

Matlab 7.8 was used to obtain the following results. Figure 5 shows the original hand image. Figure 6 shows the hand image after removing the unwanted regions. Figure 7 shows the resized original image. Figure 8 shows the segmentation results using mask method. Figure 9 shows the vein pattern obtained using maximum curvature method and figure 10 shows the overlaying of the vein pattern on the original hand image.

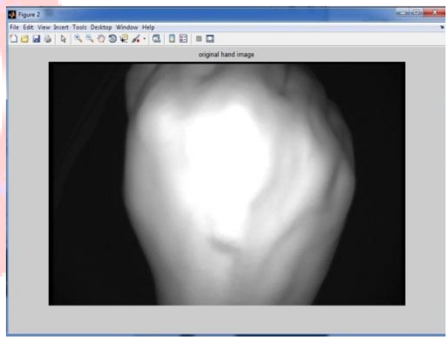

Figure 5: Original hand image

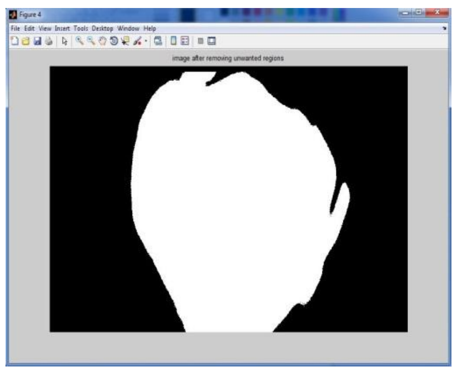

Figure 6: Image after removing unwanted regions

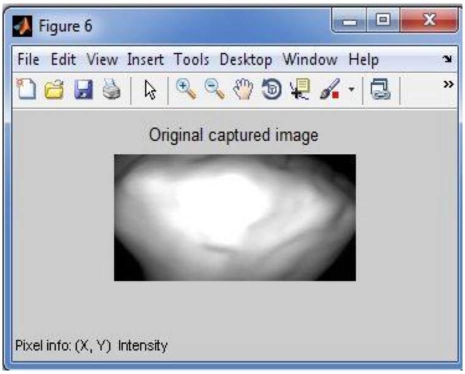

Figure 7: Resized original hand image

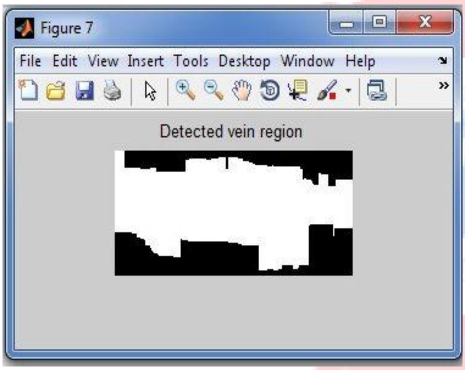

Figure 8: Segmentation results using mask based method

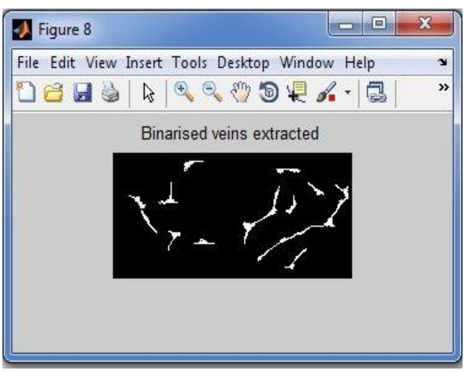

Figure 9: Binarised veins

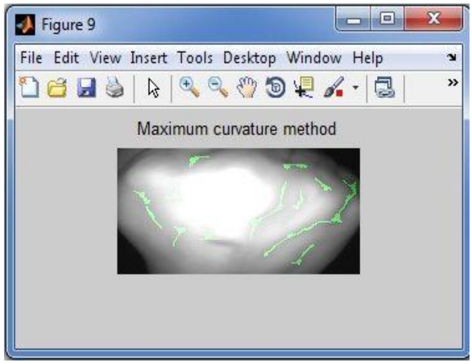

Figure 10: Overlaying of extracted vein pattern on the resized image

7. CONCLUSION

Vein pattern is extracted from the hand image successfully. It can be later matched with the template to authenticate a person. According to the proposed system vein pattern recognition is an efficient way of authenticating than the commonly used methods like passwords and smart cards which can be duplicated.

8. REFERENCES

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