Design and Construction of Finger Vein Identification System

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INTRODUCTION

Personal identification technology is applied to a wide range of systems including area-access control, PC login and e-commerce. Biometrics is the statistical measurement of human physiological or behavioral traits.

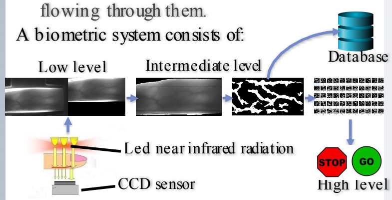
In the area of biometric identification, security and convenience of the system are important. In particular, the systems require high accuracy and fast response times. Biometric methods include those based on:

	IRIS	VOICE	FACE	FINGER PRINT	VEIN
EASY TO USE		■	■	■	■
CHEAP		■	■	■	■
ACCURATE	■			■	■
SECURE	■			■	■
TOLERANCE OF FORGERY	■				■

Using vein patterns as an identifier over fingerprints has its obvious advantages.

- First, the vein pattern is extremely hard, if not impossible, to steal unlike finger prints.
- Secondly, veins must actively have blood flowing through them.

A biometric system consists of:



PURPOSE

To develop highly accurate personal identification systems, finger-vein patterns should be extracted precisely from the captured images, and the process must be executed speedily in order to satisfy requirements for user convenience.

Conventional methods for extracting line-shaped features from images include the:

- matched-filter method
- mathematical morphology
- connection of emphasized edge lines
- ridge line following for minutiae detection

in grayscale fingerprint images.

The matched-filter and morphological methods:

- emphasize irregular shading, which presents an obstacle to personal identification since this obscures parts of the pattern of veins
- dots of noise are also emphasized because continuity is not considered.

The connection of emphasized edge lines is used to extract a finger-vein pattern, however:

- the differential operation and optimization of the line connections carry immense computational costs.
- this method is not suitable when real time processing is required.

The ridge line following

- works well if the ridge appears clearly
- extract not quite clear finger vein images.

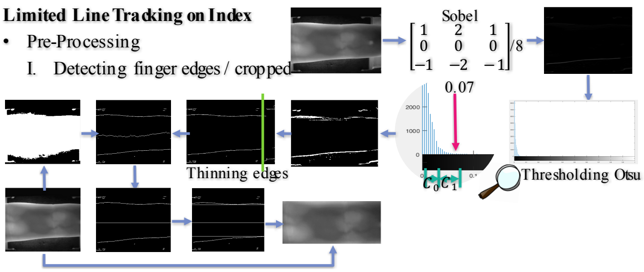
We propose a method that solves the problems described above. The method is based on limited line tracking. Local dark lines are identified, and line tracking is executed by moving along the lines, pixel by pixel. When a dark line is not detectable, a new tracking operation starts at another position.

METHOD

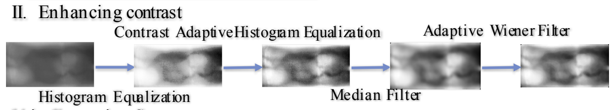
Limited Line Tracking on Index

- Pre-Processing

I. Detecting finger edges / cropped



II. Enhancing contrast

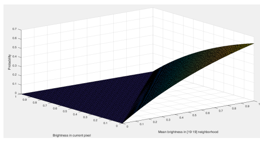


- Vein Extraction Strategy

In the procedure of repeated line tracking, when tracking begins from tracking points near each other, tracking follows similar paths. Therefore, line tracking from all pixels in the finger region is not required. Eliminating some start points for line tracking reduces the computational costs while retaining accuracy in extraction. The starting point for each line tracking operation is determined by using the MONTE CARLO SIMULATION. One line tracking is described by the following steps.

I. Local Thresholding

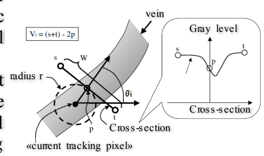
As the points in finger vein region are always darker than non finger vein region, we can focus on each point to figure out whether it is darker than its neighbourhood. The function that implements this probability map is depicted in the right figure.



II. Modified Line Tracking

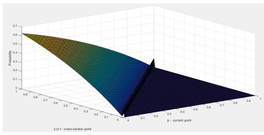
Still there are some regions which are indeed the vein but not found. Another characteristic of finger vein is the valley cross-sectional brightness profile.

A pixel to which the current tracking point moves must be within the finger region, have not been a previous within the current round of tracking, and be one of the neighboring pixels of current pixel.

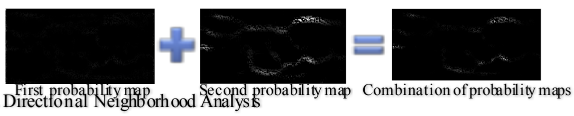


For each neighbor pixel computed the end points of cross-sectional in the process shown in the right figure.

We can calculate a second probability map by knowing the positions of these points. The function that implements this probability map is depicted in the right figure.



III. Thorough Probability Map Creating



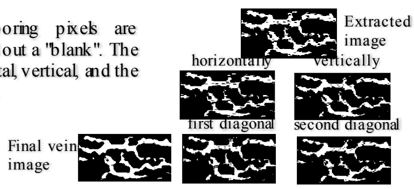
IV. Directional Neighborhood Analysis

The thorough probability map almost contains whole information of vein pattern. If we simply set a threshold and get the binary map, the result may lack enough information or include useless information. To overcome those shortcomings, we set two thresholds. One could be high, and allow some loss of data; the other is low and guarantee that data is redundant.

Then we create a moving threshold that takes values from the high to the low threshold. We check on each new image that is generated which pixels did not exist in the previous one. In this way, it is clear which of these pixels are venous regions.

V. Connection of Vein Centres

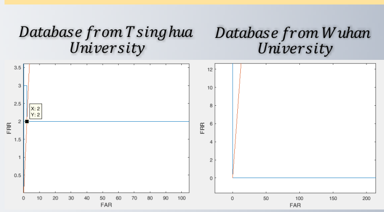
The values of neighboring pixels are checked to detect and fill out a "blank". The process is for the horizontal, vertical, and the two diagonal directional.



RESULTS

Personal identification using finger-vein patterns

To examine our method's performance for personal identification, we did an experiment using the method to identify large numbers of patterns. The experiment involved evaluating the false acceptance (FAR) and false rejection (FRR) error rates for a database of infrared finger images. The database contained 432 different infrared images of fingers, with two images per finger. The algorithm was tested using an additional database contained of 440 images, with two images per finger. It is worth noting, that the matching algorithm had great tolerance for the possible finger shifting. We calculated the receiver operating characteristic (ROC) in order to find the appropriate threshold.



ROC – Receiver Operating Characteristic

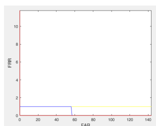
CONCLUSIONS

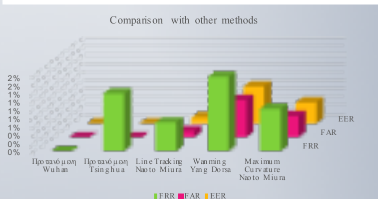
We described a personal identification method based on patterns of veins in a finger. To extract the patterns from an unclear original image, limited line tracking operations with randomly varied start points are repeatedly carried out.

e managed and suppressed the extended line tracking by Naoto Miura. The difference between the proposed method and the Wanming Yang algorithm lies in enhancing contrast, connecting of the broken points, the comparison criterion, and the tolerance to the fingers' displacement.

Two image databases were used to evaluate the method. The database from University of Tsinghua made FAR = 0% and FRR = 1.36%. While, the database from University of Wuhan made FAR = 0% and FRR = 0%. In both cases, the equal error rate was calculated as EER = 0%.

The need for greater credibility has led us to create a method based on two fingers in the index and in the middle. In the diagram below, the ROCs curves are shown using only the index (blue curve), only the middle (yellow curve) and a combination of the index and the middle (red curve).





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1. Tsinghua finger – vein finger – dorsal image database
2. Wuhan University. (accesed [03/2015]) "Finger Vein Database". [Online].
3. W.Yang, G.Ma, Fei Zhou, "*Feature-level fusion of finger veins and finger dorsal texture for personal authentification based on orientation selection*"

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