Using Finger Vein and Texture Matching Identify Human with the Help of Holistic and Nonlinear Algorithm

Mrs. Sandhya R. Shinde, Mrs Amruta Nikam

Asst. Prof, E&TC Department, Dr. D. Y. Patil Institute of Engineering, Management & Research, Akurdi,Pune-44,Maharashtra,India

---***---

Abstract: *In this paper, the finger images obtained from the database are separated into finger texture and vein images. These two images are processed separately as per the concept presented in paper. The steps involved in matching are divided into image preprocessing, image enhancement, feature extraction and feature matching. For feature extraction we have used Gabor filter and for matching we have implemented score level combination as holistic and nonlinear fusion. We compare holistic and nonlinear algorithm and proved that nonlinear is better than holistic. Finger vein and finger texture matching system has better than the existing security systems. The vein pattern is not detectable to human vision without any special device and it will not produce any trace in any object.*

Keywords—Image Preprocessing, Image Enhancement, Feature Extraction, Matching.

I. INTRODUCTION

A new way for personal identification that utilizes simultaneously acquired finger texture and finger-vein images are presented. Another addition in this paper is on the development of new method for both the finger-vein and finger texture identification, which achieves significantly improve the performance over previously proposed methods. Our finger-vein identification way utilizes peg-free and more user-friendly unconstrained imaging. Thus the methods for the acquiring finger-vein image normalization, rotational alignment, and segmentation to effectively minimize resulting interclass variations. Block diagram of proposed method is as shown in Fig.1.

Finger texture identification: Input is finger texture image and by applying pre processing steps and feature extraction steps, we get output as finger texture feature extraction image.

Finger texture matching: The texture feature extraction image is correlated with enrollment database to check whether it is matching or not. The output is finger texture image.

Score combination step: Input images are finger vein, finger texture and enrollment database and by applying holistic and nonlinear fusion we get output as whether the fingerprint is genuine or not.

III. Module description

A. Finger Vein Identification

1. Image preprocessing:

Finger images include noise with rotational and translational variations. To eliminate these variations, it is subjected to preprocessing steps.

a) Image normalization
b) ROI extractor
c) Image enhancement

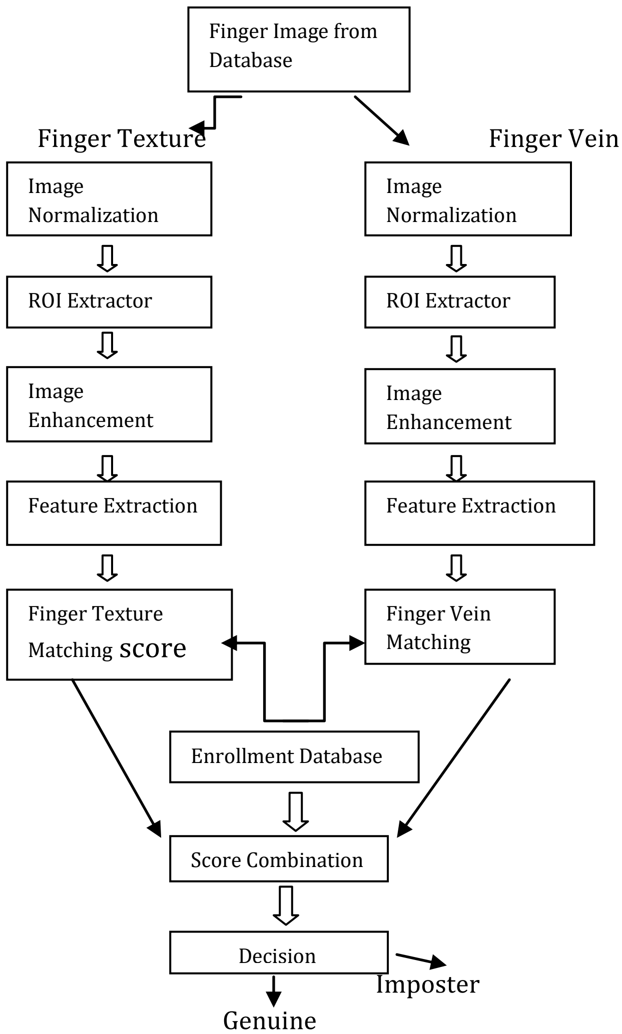


Fig.1. Block Diagram for personal identification using simultaneous finger vein and finger texture matching.

a) *Image normalization:*

Normalization is defined as changes the range of pixel intensity values. In this, the image is subjected to binarization with threshold value of 230. Sobel edge detector is applied to the image to remove background portions connected to it. Eliminating the number of connected white pixels being less than a threshold, to obtain the binary mask.

Binarization is a process of transforming grayscale image pixels into either white or black pixels by selecting a threshold. Fingerprint Image Binarization is to transform the 8-bit Gray fingerprint image to a 1- bit image with 0-value for ridges and 1-value for furrows. After the operation, ridges in the fingerprint are marked with black color while furrows are white. A locally adaptive binarization method is performed to binarize the fingerprint image.

b) *ROI extractor:*

In the finger images, there are many nonessential regions (that cannot be taken for analysis) has been removed by choosing the interested area in that image. The useful area is said to be "Region of Interest". The retrieved binary mask is used to segment the ROI (Region of Interest) from the original finger-vein image. The orientation of the image is determined to remove the low quality images that present in finger vein image.

c) *Image Segmentation:*

Only a Region of Interest (ROI) area is useful to be recognized for each fingerprint image. The image area without effective ridges and furrows is first discarded since it only holds background information. Then the bound of the resting effective area is give out since the minutia in the bound region is confusing with that spurious minutia that is generated when the ridges are out of the sensor. To extract the ROI, a two-step method is used. These two methods are described below:

i. Block direction estimation:

The direction for each block of the fingerprint image with size of W x W (W is 16 pixels by default) is estimated. The algorithm is:

I. The gradient values along x direction (gx) and y direction (gy) for each pixel of the blocks are calculated. Two Sobel filters are used to fulfill the task.

II. For each block, following formula is used to get the Least Square approximation of the block direction.

$$tg2\beta = 2\sum\sum(gx * gy)/\sum\sum(gx^2 - gy^2) \quad (1)$$

For all the pixels in each block.

The formula is clearly understood by regarding gradient values along x-direction and y-direction as cosine value and sine value. So the tangent value of the block direction is estimated nearly the same as the way illustrated by the following formula.

$$tg2\theta = 2\sin\theta\cos\theta/(\cos 2\theta - \sin 2\theta) \quad (2)$$

After the estimation of each block direction are discarded based on the following formulas:

$$E = \{2\sum\sum(gx * gy) + \sum\sum(gx^2 - gy^2)\}/W * W * \sum\sum = (gx^2 + gy^2) \quad (3)$$

For each block, if its certainty level E is below a threshold, then the block is regarded as a background block.

ii.ROI extraction by Morphological operations:

Two Morphological operations are called as 'OPEN' and 'CLOSE' are adopted. The 'OPEN' operation can expand images and remove peaks introduced by background noise. The 'CLOSE' operation can reduce images and remove small cavities. The bound is the subtraction of the closed area from the opened area. Then the algorithm clear those rightmost, leftmost, uppermost and bottommost blocks out of the bound so as to get the tightly bounded region just containing the bound and inner area.

d) *Image enhancement:*

The acquired image is thin and it is not clear, so the image is enhanced by using bicubic interpolation for better decision. Fingerprint Image enhancement is to make the image fair for easy further operations. Since the fingerprint images taken from sensors or other Medias are not assured with perfect quality, those enhancement methods, for increasing the contrast between ridges and furrows and for connecting the false broken points of ridges due to insufficient amount of ink, are very useful for keep a higher accuracy to fingerprint recognition. The Method used in fingerprint recognition system is Histogram Equalization

Histogram equalization is to expand the pixel value distribution of an image so as to increase the perceptional information.. The histogram after the histogram equalization uses all the range from 0 to 255 and the visualization effect is enhanced.

B. Finger Texture Image Preprocessing

1. Localization and Normalization:

In texture image preprocessing, Sobel edge detector is used to obtain the edge map and localize the finger boundaries. This edge map is isolated with noise and it can be removed from the area threshold. Such noise is removed from the area Thresholding, i.e., if the number of consecutive connected pixels is less than the threshold. The slope of the resulting upper finger boundary is then estimated.

This slope is used to localize a fixed rectangular area, its start at a distance of 20 pixels from the upper finger boundary and is aligned along its estimated slope. We extract a fixed 400* 160 pixel area, at a distance of 85 and 50 pixels, respectively, from the lower and right boundaries, from this rectangular region. For the identification this 400 *160 pixel image is used as the finger texture image

1) **2. Image Enhancement:**

In image enhancement, finger texture image is subjected to median filtering to eliminate the impulsive noise. The resulting images have low contrast and uneven brightness. Therefore obtain the background illumination image from the average of pixels in 10∗ 10 pixel image sub blocks and bicubic interpolation. The resulting image is deducted from the median-filtered finger texture image and then passes to histogram equalization.

C. Finger Vein Identification Finger Vein and Texture Image Feature Extraction

Gabor filter is used for finger vein and texture image feature extraction. Gabor filters optimally taking both local orientation and frequency information from a fingerprint image. By regulating a Gabor filter to desired frequency and direction, the local frequency and orientation information can be obtained. We have constructing the Gabor with specified orientations and these Gabor filter is convolved with the enhanced image to remove the unwanted regions other than the vein and texture regions.

$$G(x,y) = s(s,y)g(x,y) \quad (4)$$

where $s(x,y)$ is complex sinusoid and $g(x,y)$ is 2D gaussian envelope

$$s(x,y) = \exp[-j2\pi(\mu0x + v0y]) \quad (5)$$

$$g(x,y) = \frac{1}{\sqrt{2\pi\sigma x\sigma y}}\exp[-\frac{1}{2}(\frac{x^2}{\rho x^2} + \frac{y^2}{\sigma y^2})] \quad (6)$$

σ_x And σ_y characterize the spatial extent and bandwidth of along the respective axes, $u_o$and $v_o$are the shifting frequency parameters in the frequency domain.

D. Finger Vein and Texture Matching:

For matching purpose we are use SURF algorithm:

1. Detect SURF feature
   i) count
   ii) Location
   iii) Scale
   iv) Metric
   v) Sign of Laplacian
   vi) Orientation
2. Extract Feature
3. Match Feature
4. Retrieves the location
5. Show match feature

Matching Score= *Total no. of count of feature match/ Total size of image*

E. Score Combination:

In score level combination, two methods are used.

a) Holistic fusion
b) Nonlinear fusion

These two methods are used to combine the resultant finger vein and texture images. The result of this fusion is used to check whether the fingerprint is genuine or not.

a) Holistic Fusion:

This method is developed and investigated to utilize the prior knowledge in the dynamic combination of matching scores. Let s_v, s_t and $\hat{s}$ represent the matching score from finger vein, finger texture, and combined score, respectively, and this holistic rule of score combination is given below:

$$s^{\wedge} = \{\{(s_v * \eta) + (s_t * (1-\eta))\} + \frac{\{(s_v * \eta) + (s_t * (1-\eta))\}}{(2-s_v)} \quad (7)$$

The above equation can also be written as,

$$\hat{s} = \{(s_v * \eta) + ((s_t * (1-\eta))\} * (1 + \frac{1}{2-s_v}) \quad (8)$$

With the help of this equation, the concluding combined scores have a similar trend as the score from vein matching, i.e., when the score from finger-vein matching is high, the fused score will also become high and vice versa. Factor η is selected to reflect the reliability of each modality or matching score. We prefer the matching score from finger vein as the regulating factor since the performance of finger-vein matching is more stable, as compared with that of the texture.

b) Nonlinear Fusion:

For nonlinear score combination we used following formula

$$\hat{s} = \left(\frac{c+s_t}{c+s_v}\right)^{\gamma} * (c + s_v)^2 \quad (9)$$

Where γ is a positive constant and is fixed to 1 and is selected in the range of [1, 2].

IV. Experimental result

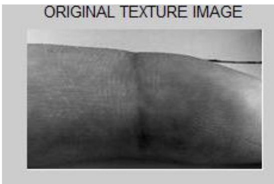
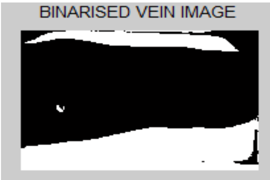


Fig.1. Original Vein Image Fig.2.Original Texture Image



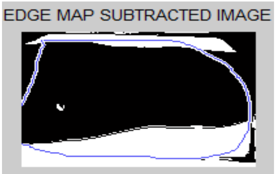


Fig.3.Binarised Vein Image Fig.4.Edge Map Subtracted Image

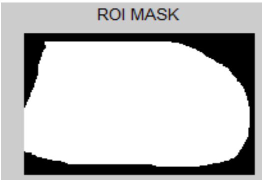
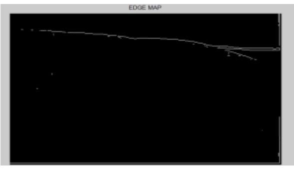


Fig.5.ROI(Region Of Interest) Mask Fig.6..ROI Finger Vein Image

Fig.7.Enhanced finger vein Image Fig.8.Feature Extracted Vein Image



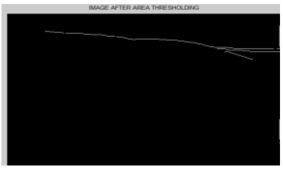


Fig.9.Edge Map Fig.10. Image after Area Thresholding

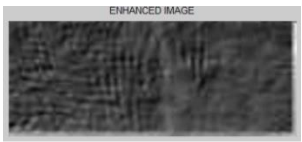
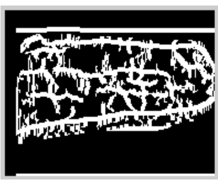


Fig.11.Rectangualar Region Fig.12.Enhanced Image



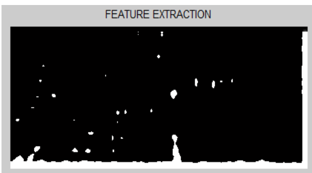
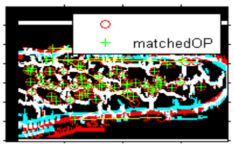


Fig.12.Feature Extraction vein image Fig.13.Feature Extraction Texture



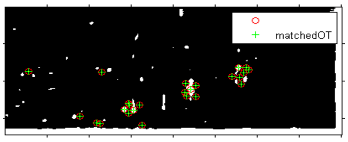


Fig.14.Vein Match Fig.15.Texture Match

Table-1: Combined Performance (EER) & accuracy using Holistic and Nonlinear Method

Combination Approaches	EER of Finger Images	Matching Accuracy
Holistic Fusion	1.12%	98.87%
Nonlinear Fusion	0.85%	99.14%

V. conclusion:

This dissertation presents a fully automated finger image matching framework by simultaneously utilizing the finger vein and finger texture. Two algorithms have been used namely nonlinear and holistic, for effectively combining simultaneously generated finger-vein and finger texture matching scores. The nonlinear approach consistently performed better than holistic. By using Holistic equation, if the score from vein matching is high, the fused score will also become high. We choose the matching score finger vein as the controlling factor since the performance of finger-vein matching is more stable, as with that of the texture.

References:

[1] Encyclopedia of Biometrics, S. Z. Li, Ed.. New York: Springer- Verlag, 2009.

[2] A.K. Jain, Y. Chen, andM. Demirkus, “Pores and ridges: High resolution fingerprint matching using level 3 features,” IEEE Trans. Pattern Anal. Mach. Intell., vol. 29, no. 1, pp. 15–27, Jan. 2007.

[3] Handbook of Remote Biometrics, R. Chellappa,M. Tistarelli, and S. Z.Li, Eds. New York: Springer-Verlag, Jul. 2009.

[4] P. Kallo, I. Kiss, A. Podmaniczky, and J. Talosi, “Detector for recognizing the liveness character of a finger in fingerprint recognizing apparatus,” U.S. Patent 6 175 641, Jan. 16, 2001.

[5] D. Osten, H. M. Carin, M. R. Arneson, and B. L. Blan, “Biometric personal authentication system,” U.S. Patent 5 719 950, Feb. 17, 1998.

[6] S. T. V. Parthasaradhi, R. Derakhshani, L. A. Hornak, and S. A. C. Schuckers, “Time-series detection of perspiration as a liveness test in fingerprint devices,” IEEE Trans. Syst., Man, Cybern. C, Appl. Rev., vol. 35, no. 3, pp. 335–343, Aug. 2005.