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Finger Vein Verification with the Help of Gabor Filter and Repeated Line Tracking

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Abstract: Finger vein is a unique physiological biometric for identifying individuals based on the physical characteristics and attributes of the vein patterns in the human. The technology is currently in use or development for a wide variety of applications. The proposed system simultaneously acquires the finger-vein and low-resolution finger image images and combines these two evidences using a novel score-level combination strategy. We examine the previously proposed finger-vein identification approaches and develop a new approach that illustrates it superiority over prior published efforts. In this thesis I developed and investigated two new score-level combinations, i.e., Gabor filter and Reapted Line Tracking, and comparatively evaluate them with more popular score-level fusion approaches to ascertain their effectiveness in the proposed system.

Keywords: Finger-vein recognition, Gabor filter, Biometrics, Image Recognition and Reapted Line Tracking.

I. INTRODUCTION

Biometric is the technology of verifying people using human physiological or behavioral features such as fingerprint, iris, face and voice. Due to the fact that a hand contains lots of information and the information is easy to be retrieved, hand based biometrics such as fingerprint and palm print are the most popular biometric technologies. Fingerprint is the most mature hand based biometric method where it has been used in many applications for years. However, fingerprint based biometric system is vulnerable to forgery because the fingerprints are easily exposed to the others. In addition, the condition of the finger's surface such as sweat and dryness can prevent a clear fingerprint pattern from being obtained. This can degrade the system's performance. To overcome the limitations of current hand based biometric systems, finger vein recognition had been researched. They proved that each finger has unique vein patterns so that it can be used in personal verification. Finger vein based biometric system has several benefits when compared with other hands based biometric methods.

The finger vein pattern is hard to replicate since it is an internal feature. In addition, the quality of the captured vein pattern is not easily influenced by skin conditions as compared with palm vein based verification system, the size of the device can be made much smaller.

A. Motivation And Related Work:

The blood vessels, as part of the circulatory system, transport blood throughout the body to sustain the metabolism, using a network of arteries, veins, and capillaries. The use of such vascular structures in the palm, palm–dorsal, and fingers has been investigated in the biometrics literature [2]–[9], [13]–[15] with high success. The finger-vein patterns are believed to be quite unique, even in the case of identical twins and even between the different fingers of an individual. There are two key factors that are cited for the preference of finger-vein biometrics. First, the finger veins are hidden structures; it is extremely difficult to steal the finger-vein patterns of an individual without their knowledge, therefore offering a high degree of privacy. Second, the use of finger-vein biometrics offers strong antispoofing capabilities as it can also ensure liveness in the presented fingers during the imaging. The biometrics identification from finger-vein patterns using normalized cross correlation of finger-vein images is detailed in [7].

Miura *et al.* [5] have further improved the performance for the vein identification using a repeated line tracking algorithm. The robustness in the extraction of finger-vein patterns can be significantly improved with the use of local maximum curvature across the vein images and is detailed in [6] with promising results. Wu and Ye [3] have successfully investigated finger-vein identification using Radon-transform-based statistical features and a probabilistic neural network classifier. Human hands are easier to present, convenient to be imaged,and can reveal a variety of features that can be observed with a variety of illuminations (e.g., visible, near infrared, or thermal infrared) and in a wide range of imaging resolutions. In addition to fingerprint features [11], the palmprint [12], finger knuckle [10] and hand geometry [1] acquired in visible illumination, and palm-vein features acquired from near-infrared [15] and far-infrared [13] imaging have invited lot of attention from researchers and developers over the last decade.

B. Finger Image Features:

The most common representation used in Finger image identification is the Galton features. A ridge can be defined as a single curve segment. The combination of several ridges forms a finger image pattern. The small features formed by crossing and ending of ridges are called minutiae. Ridge Ending & Bifurcation are taken as the distinctive features of finger image. In this method the location & angle of the feature are taken to represent the finger image & used in the matching process. Together with there, finger image contains two special types of feature called core & delta points. The core point is generally used as a reference point for coding minutiae & defines as the topmost point on the innermost recurring ridge. The core & delta are also called the singularity points.

C. Finger Image Recognition:

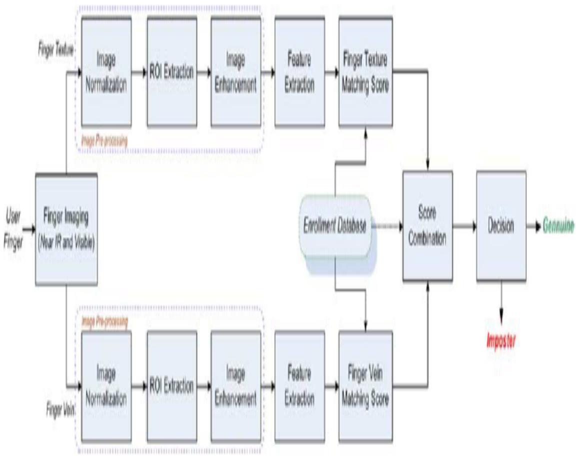
The uniqueness and permanence of the finger image are very well-know. Archaeological artifacts prove those finger images were already used by the ancient Assyrians and Chinese as a form of identification of a person. The first scientific studies on finger image date from the late sixteen century, but the fundamentals of modern finger image identification methods were provided at the end of nineteenth century. The studies of Sir F. Galton and E. Henry led to formally accept finger image as valid signs of identity by law Enforcement agencies. The first Automated Finger image Identification Systems (AFIS) were developed in the 1950s by the F.B.I. (Federal Bureau of Investigation) in cooperation with the National Bureau of Standards, the Cornell Aeronautical Laboratory and Rockwell International Corp.

D. Finger-Vein Image preprocessing:

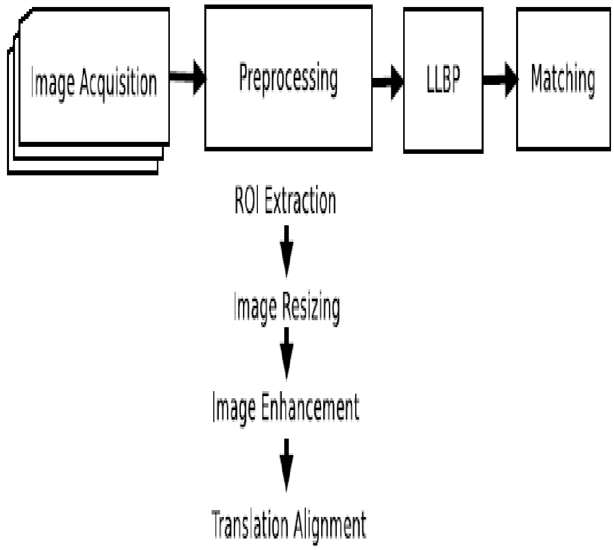
The acquired finger images are noisy with rotational and translational variations resulting from unconstrained imaging. Therefore, the acquired images are first subjected to preprocessing steps that include:

a. Segmentation of ROI,
b. Translation and orientation alignment, and
c. Image enhancement to extract stable/reliable vascular patterns.

Each of the acquired finger-vein images is first subjected to binarization, using a fixed threshold value as 230, to coarsely localize the finger shape in the images. Some portions of background still appear as connected to the bright finger regions, predominantly due to uneven illumination. The isolated and loosely connected regions in the binarized images are eliminated in two steps: First, the Sobel edge detector is applied to the entire image, and the resulting edge map is subtracted from the binarized image. Subsequently, the isolated blobs (if any) in the resulting images are eliminated from the area thresholding, i.e., the eliminating number of connected white pixels being less than a threshold. The resulting binary mask is used to segment the ROI from the original finger-vein image.



Block diagram for personal identification using simultaneous finger-vein and finger texture imaging.



E. Repeated Line Tracking:

The repeated line tracking method gives a promising result in finger-vein identification: The idea is to trace the veins in the image by chosen directions according to predefined probability in the horizontal and vertical orientations, and the starting seed is randomly selected; the whole process is repeatedly done for a certain number of times.

Table 1 and 2 shows the outputs come during the matching of veins.

Table 1

FAR	GAR
Repeated line tracking	
0	0.25
10 -4	0.3
10 -3	0.4
10 -2	0.6
10 -1	0.86
10 0	1
Even Gabor	
0	0.33
10 -4	0.4
10 -3	0.5
10 -2	0.7
10 -1	0.92
10 0	1
Combined Method	
0	0.5
10 -4	0.49
10 -3	0.6
10 -2	0.79
10 -1	0.95
10 0	1

Table 2

FAR	GAR
Repeated line tracking	
0	0.53
10 -4	0.55
10 -3	0.65
10 -2	0.8
10 -1	0.94
10 0	1
Even Gabor	
0	0.5
10 -4	0.65
10 -3	0.78
10 -2	0.85
10 -1	0.97
10 0	1
Combined Method	
0	0.73
10 -4	0.83
10 -3	0.88
10 -2	0.89
10 -1	0.97
10 0	1

F. Gabor Filter:

It is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. The Gabor filters are self-similar: all filters can be generated from one mother wavelet by dilation and rotation.

Formula:

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = exp\left(\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right)\exp\left(i\left(2\pi\frac{x'}{\lambda} + \psi\right)\right)$$

II. OUR WORK AND OUTPUTS

In this paper, we have presented a complete and fully automated finger image matching framework by simultaneously utilizing the finger surface and finger subsurface features, i.e., from finger texture and finger-vein images. Second, we presented a new algorithm for the finger-vein identification, which can more reliably extract the finger-vein shape features and achieve much higher accuracy than previously proposed finger-vein identification approaches. Third, we proposed and investigated two new score-level combination approaches, i.e. Gabor filter and Reapted Line Tracking, for effectively combining simultaneously generated finger-vein and finger texture matching scores

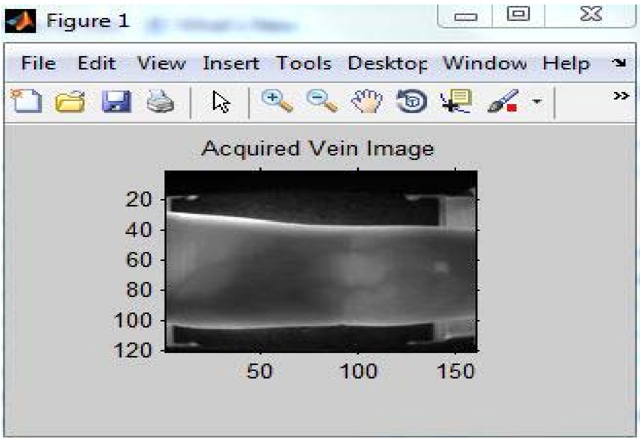


Figure:1 shows the acquired vein image to be matched

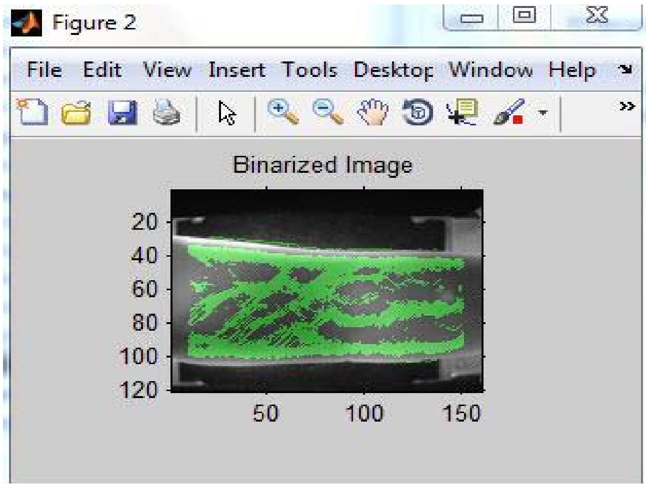


Figure: 2 shows the binarized image

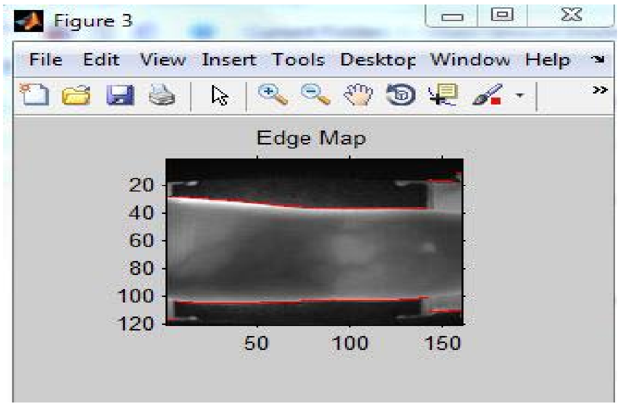


Figure: 3 shows the edge mapping of the finger

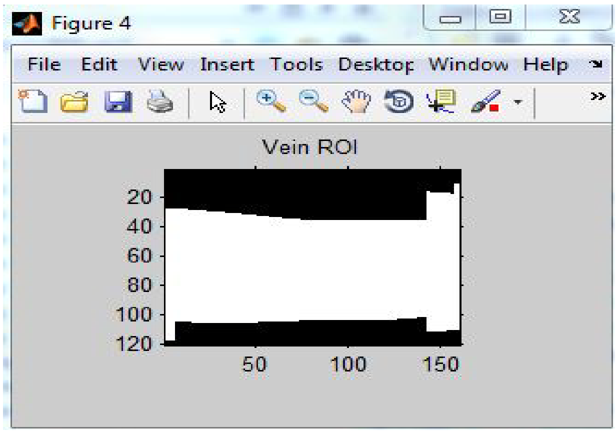


Figure: 4 shows the vein ROI

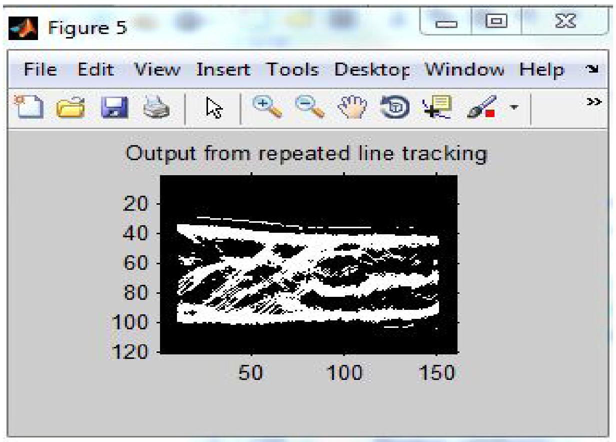


Figure: 5 shows output come after repeated line tracking

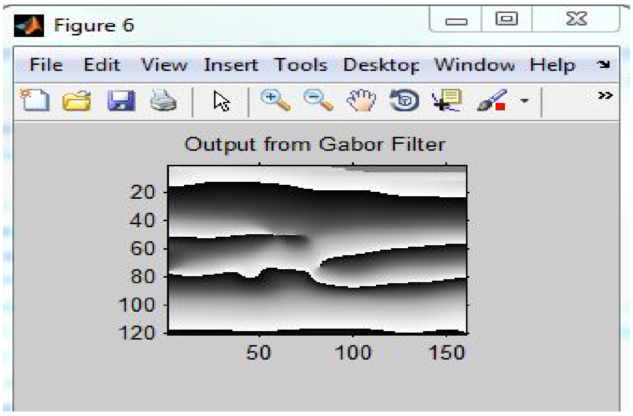


Figure: 6 shows the output of Gabor Filter

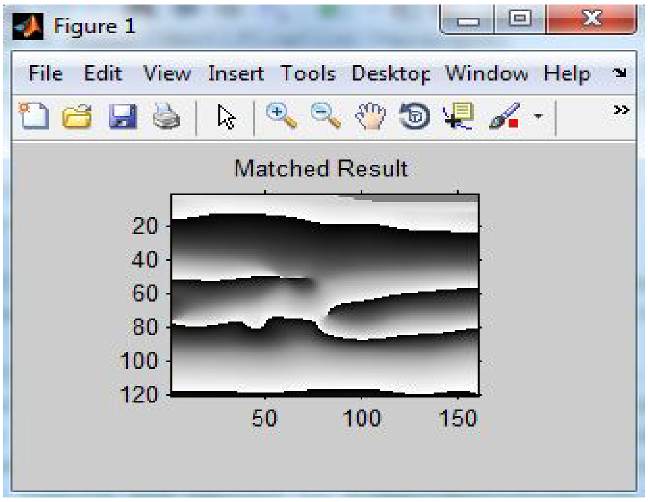


Figure: 1 shows the matched result from the database

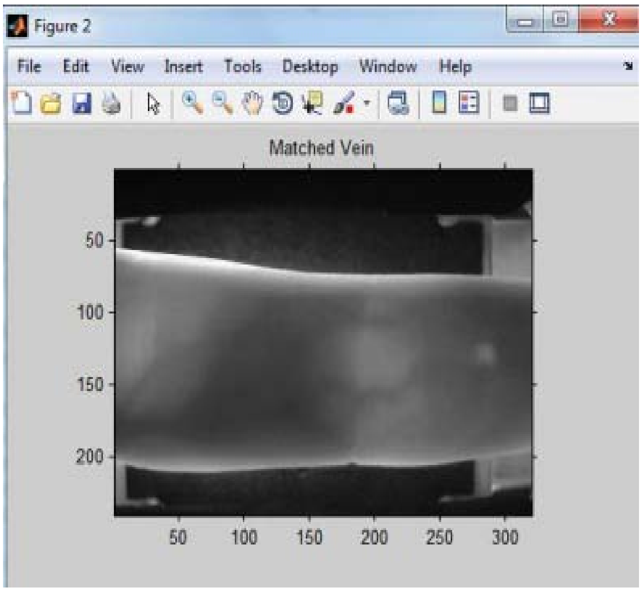


Figure: 2 shows the matched Vein

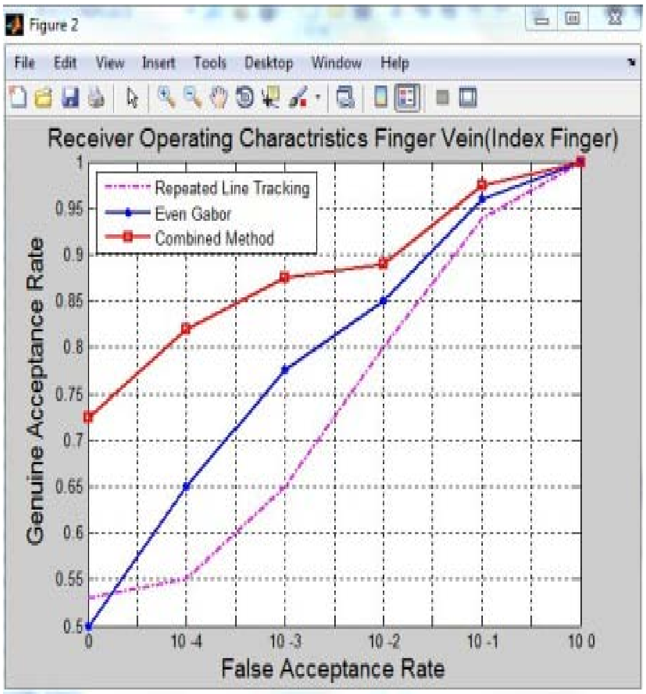


Figure: 2 shows the overall results come after comparing with the index finger

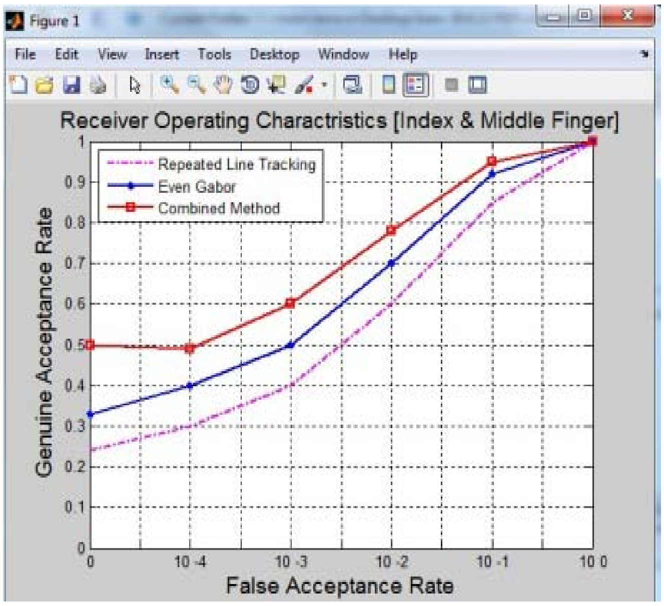


Figure: 1 shows the overall results come after comparing with the index and middle finger

III. CONCLUSION

This system simultaneously acquires the finger-vein and low-resolution finger images and combines these two evidences using a novel score-level combination strategy. We develop and investigate two new score-level combinations, i.e., Gabor filter and Repeated Line Tracking, and comparatively evaluate them with more popular score-level fusion approaches to ascertain their effectiveness in this system.

IV. REFERENCES

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