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Personal Authentication Using Finger Vein Biometric

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ABSTRACT: Biometrics is defined as the recognition of a person using different characteristics or traits automatically. Finger vein based biometric recognition has increasingly generated interest amongst biometric researchers because of the accuracy, robustness and anti-spoofing properties. This idea proposes a new approach for personal authentication using finger back surface imaging. The texture pattern produced by the finger knuckle bending is highly unique and makes the surface a distinctive biometric identifier. The authentication system investigates a finger vein biometric approach by exploring the vein pattern that is present in the dorsal finger region. Thus, the dorsal finger vein pattern can be used as an independent biometric characteristic useful for the recognition of the target subject. This system proposes a complete automated approach with the key steps of image capturing, Region of Interest (ROI) extraction, pre-processing to enhance the vein pattern, feature extraction and comparison.

KEYWORDS: Biometric, Vein pattern, authentication, image capturing, pre-processing, extraction

I. INTRODUCTION

Security and authentication of individual's identity should be two essential aspect of any biometric system. There are numerous fields worldwide which are needed an accurate authentication of person working and security of what they are doing. Biometric helps to acquire these two aspects using its own features. There are many existing biometric systems like fingerprint, iris biometric system, DNA profiling and all of these has their own prone and cons. Finger vein pattern based biometric has been seeking a lot of attention from last few years as it has its unique features which has make it better than other existing biometric systems. Finger vein are internal part hence impossible to forge, unique, reliable ,secure because not traceable by eye, less failure to enroll rate (FET), no issues of wet, dry, dirt like finger print. Here in this paper we proposed an authentication based on vein patterns of palm-dorsa fingers. We present different feature extraction schemes classified into local and global feature extraction methods. The methods are Wide Line Detector (WLD)[2], Spectral Minutiae representation (SMR) [3], Competitive coding (CC) [4], Repeated Line Tracking (RLT) [5].Finger vein has different features such as ridges, bifurcation ,valleys. These features are unique for every vein pattern of every individual. The database is used is of 10 users. 18 images of each users middle, index and ring finger make it a database of 180 [11].

II. RELATED WORK

In the literature the use of finger vein images has generated increasingly interest for the biometric identification. A vein biometric based authentication system mainly consists of pre-processing, vein enhancement, feature extraction, feature matching.

(a)Vein enhancement and extraction

To minimize the effect of low local contrast, nonuniform illumination and noise present in the acquired vein image, it is enhanced before vein extraction. Such minimization is done using different filtering techniques based on Steerable filter[12],Gabor filter[13], Curvelet filter[14].These performed poorly for variable width veins because they are based on the shape of local neighborhoods of vein patterns.To extract the patterns from unclear image maximum curvature point information can be used along with line tracking [2].Thin veins can be tracked from fewer location,such

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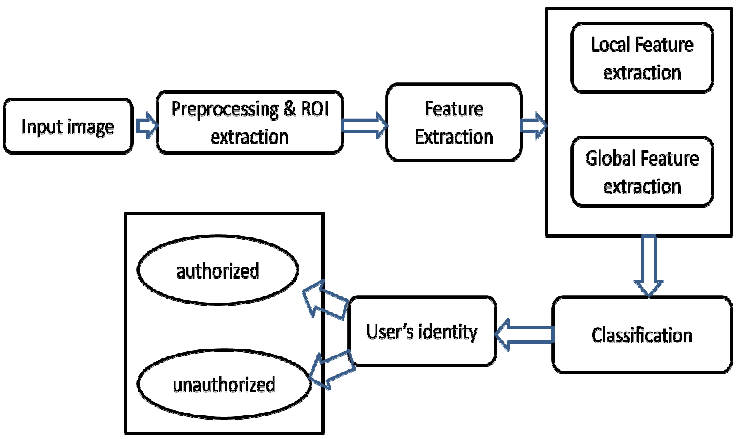
information may be missed in some cases.spurious vein generated due to avoidance of local vein shape ,this scattering effect in IR imaging is removed by using restoration algorithms[15,16].Global and local thresholding is further applied to the enhanced vein image to extract the vein pattern

(b)Feature extraction and matching
There are several researchers which have exploited different fearute extraction methods and algorithms.Local and global features are extracted from the vein and further use for matching.There is a wide variety of feature extraction algorithms which are broadly classified as local and global features extraction schemes.Vein endings and bifurcations are commonly used vein features which are extracted by using crossing number techniques.local features also acquired either by Maximum Curvature Points(MCP) [17] or Wide Line Detectore(WLD)[1]or the Spectral Minutiae(SMR) [13]or Repeated Line Tracking (RLT) [2].On the other side global features include both line patterns and texture that can be extracted ny Competitive Coding(CC)[10]

III. PROPOSED METHOD

We developed a method of personal authentication based on finger vein patterns of dorsal fingers. The images (Near Infra Red images) we are using here are from existing database captured by NIR sensor camera [11]. Fig.1 (a) shows the basic block diagram of the system. As mentioned above input is NIR image from given database.Fig.1 (b) shows example of infrared image of finger vein. Input image need to be processed for further operations because it may contain noise, uneven light illumination, brightness problems. Such process of noise removal is known as pre-processing of an image. Here image enhancement is done using histogram equalization which works on small region of the image; such enhanced image is used for feature extraction and comparison. Feature extraction is one of the most important step of proposed system. Feature extraction method categorized into local and global feature extraction methods. Local feature extraction method extracts only vein patterns as well as minutiae whereas global feature extraction method extracts line as well as texture information.

A. *Pre-processing and Region of Interest*
The input image is infrared image acquired by NIR camera [11].The NIR illumination is absorbed more by haemoglobin in the vein by the surrounding tissue and thus highlights the vein patterns.



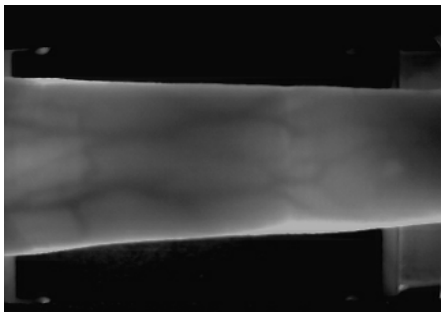


Fig.1 (a) Block diagram Of Proposed System Fig.1 (b) example of infrared image of finger vein

Accurate recognition using vein pattern images requires to process the input image by extracting appropriate ROI as well as an effective pre-processing technique that can highlight the vein patterns prominently The ROI approach should be able to extract the region of interest from the given image by discarding background as well as outer region.Fig.1 (a)

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shows an example of NIR finger image. The image is then enhanced by adjusting contrast by using CLAHE [3].This step is followed by ROI extraction that excludes the nail part. Fig.2 shows enhanced image of finger vein.

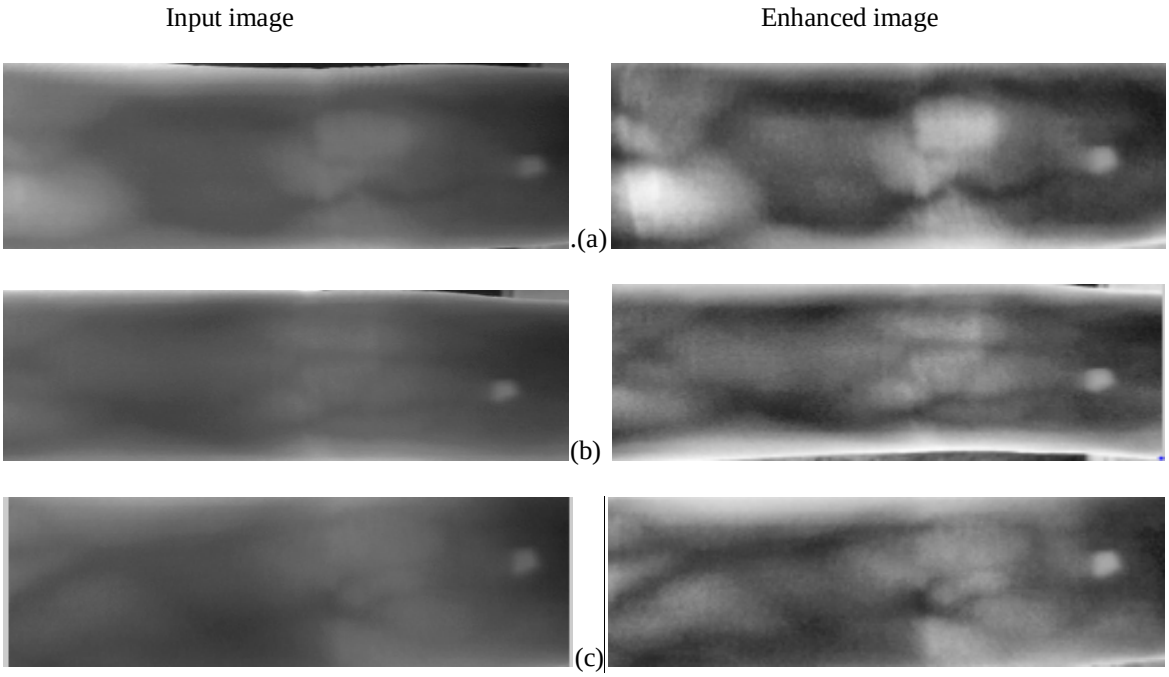

Fig.2 Finger vein pattern from the same subject
(a)Left index (b)Left middle (c)Left ring

B. Feature Extraction

Vein image biometrics generated a lot interest among researchers all over the world because it has many features which can be used as an authentication tool for personal identification(shape features, minutiae and features obtained from hand boundary shape).To build highly accurate personal identification system finger vein patterns should be precisely extracted from captured image. To this extent feature extraction is broadly classified into local and global feature extraction

Local feature extraction

Local features of a vein include vein pattern as well as vein minutiae points. In the following, we present a brief description of each of those local feature extraction schemes.

1. Wide Line Detector (WLD)

The basic problem obtained with image during image processing is some undesired conditions.i,e image quality may degrade due to some uneven illumination ,irregular distortion etc. Wide Line Detector is one of the methods used to obtain precise width information .It helps to increase information of the extracted feature from low quality image.

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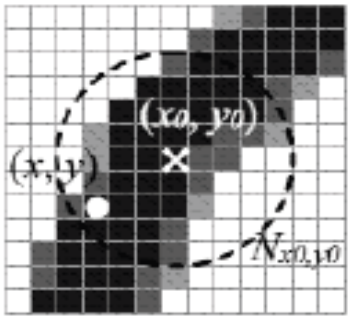

Fig.3 Circular Neighborhood Region

Where,

N (x_0, y_0) is a neighborhood region

Suppose f is a finger image and v is a feature image. Specification of v image as a part of

0 ⟶

255 ⟶ Noise

Image data

$$N(x_0, y_0) = \{(x, y) | \sqrt{(x - x_0)^2 + (y - y_0)^2} \leq r\}$$

$$V(x_0, y_0) = \begin{cases} 0 & m(x_0, y_0) > g \\ 255 & other \end{cases}$$

Where $m(x_0, y_0) = \sum(x, y) \in N(x_0, y_0) S(x, y, x_0, y_0, t)$

$$S(x, y, x_0, y_0, t = \begin{cases} 0 & f(x, y) - f(x_0, y_0) \\ 1 & otherwise \end{cases}$$

Where t,g and r are parameters.

It can obtain all the points on the lines of vein in the image and increase the information of the feature.

2. Repeated Line Tracking

RLT is a widely used approach for FV recognition. Extraction of the pattern based on num-ber of times the tracking lines pass through he points. The line-tracking starts at any pixel in captured image which is called as "current tracing point". Then the tracking point moved pixel to pixel along dark line. The number of times pixel racked as current tracking point named as "locus space". The size of locus space is equal to total number of pixels in the image

Global Feature Extraction

The global feature extraction techniques will extract texture features that are contributed due to knuckle patterns and vein pattern.

1. Competitive coding representation

It is compatible for both palm-print and fingerprint. Suppose I be enhanced dorsal finger image, The competitive code is obtained as following: $ICOPM$=min $(I\ x,y * f\ x,y,Qj)$

Where *denotes the convolution, (x,y,Qj) denotes the Gabor filter

Gabor Filter.

In image processing, a Gabor filter, is a linear filter used for texture analysis, which means that it basically analyses whether there are any specific frequency content in the image in specific directions in a localized region around the point or region of analysis. 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

2.Derivative of Gaussian Filter Code (DoG)

It is also most widely used method for hand vein biometrics. Here is Gaussian filter is used.

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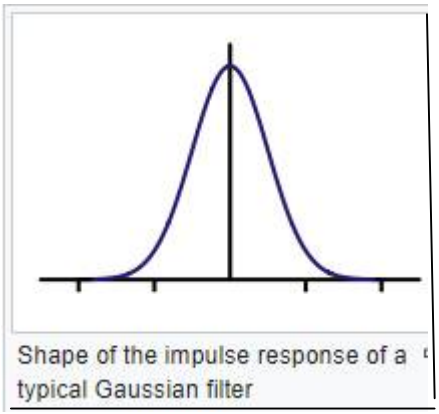
Gaussian Filter

A Gaussian filter is a filter whose impulse response is a Gaussian function (or an approximation to it). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Gaussian filter has the minimum possible group delay. It is considered the ideal time domain filter, just as the sinc is the ideal frequency domain filter



Shape of the impulse response of a typical Gaussian filter

The impulse response of 2D Gaussian filter with variance σ is given by,

$$G(x,y)=\frac{1}{2\pi\sigma^{2.}}.e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Given the enhanced dorsal finger vein image I, DoG code can by computed as follows by performing the convolution with the Gaussian derivative along x and y direction:

$I'(x) = I * G'_{\sigma x}$ - Derivative of G_σ into x direction

$I'(y) = I * G'_{\sigma y}$- Derivative of G_σ into y direction

Where $*$ denote convolution operator.

The derivative of the Gaussian is encoded according to the sign of each pixel of $I'(x)$ and $I'(y)$ is given as follows:

$$I_{cx} = \begin{cases} 1 & I'_x \geq 0 \\ 0 & otherwise \end{cases}$$

$$I_{cy} = \begin{cases} 1 & I'_y \geq 0 \\ 0 & otherwise \end{cases}$$

Finally the DoG code is obtained as $I_{DoG}= [I_{cx} \quad I_{cy}]$

$$G(x,y)=\frac{1}{2\pi\sigma^{2.}}.e^{-\frac{x^2+y^2}{2\sigma^2}}$$

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Comparison

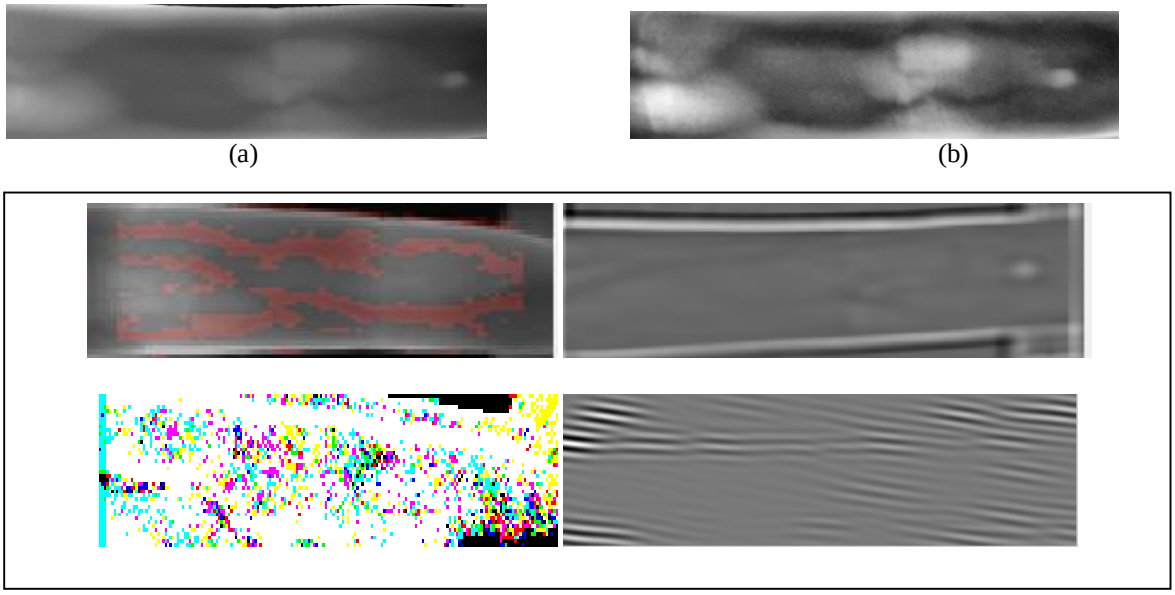
In this section, two different comparators for local and global feature are used. In order to compare local feature we have used non-commutative template comparison algorithm[8].This method computes the maximum correlation between reference and probe local feature vector. In case of global feature, hamming distance measure to compute the reference and probe global feature vector.

Template Matching

Template matching is a technique in digital image processing for finding small parts of an image which match a template image. It can be used in manufacturing as a part of quality control, as a way to detect edges in images.

Global feature comparator

In case of global feature, hamming distance measure to compute the reference and probe global feature vector.



(a) (b)

(c) (d)

Fig.4 Qualitative results of feature extraction techniques
(a) input image (b) Enhanced image (c) Local features (d) global features

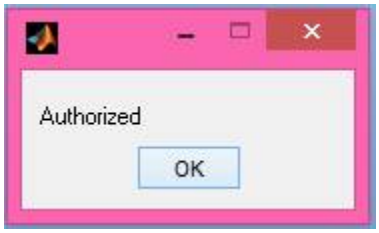


Fig.4(e) Recognition result

Figure 4 shows the qualitative results of both local and global features employed in this work. Fig.4 (a) shows an input NIR image of ring finger of user while fig.4 (b) shows enhanced image after pre-processing. Fig.4 (c) shows result of feature extracted using WLD,SMR(from top to bottom)and fig.4(d) shows features extracted using CC and DoG. Fig.4(e) shows recognition result that the given user is authorized.

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C. Experimental Results

Table 1 represent the recognition accuracy using proposed method. It describes the parameters like sensitivity, specificity and efficiency. Here range of ROC curve is from (0-1).

Parameter	Value
Max Sensitivity Cut-off point	194.00
Max Specificity Cut-off point	107.00
Cost effective Cut-off point	148.00
Max Efficiency Cut-off point	161.00

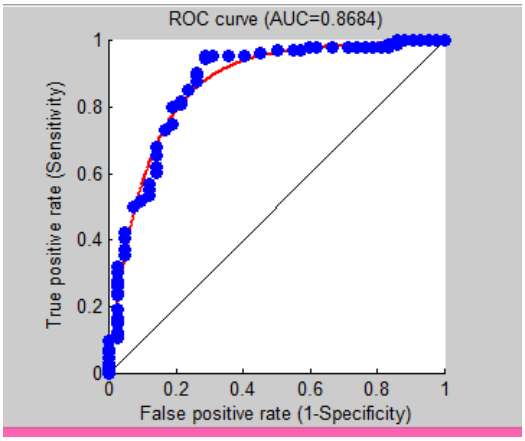

Fig.5 (a) Roc Curve

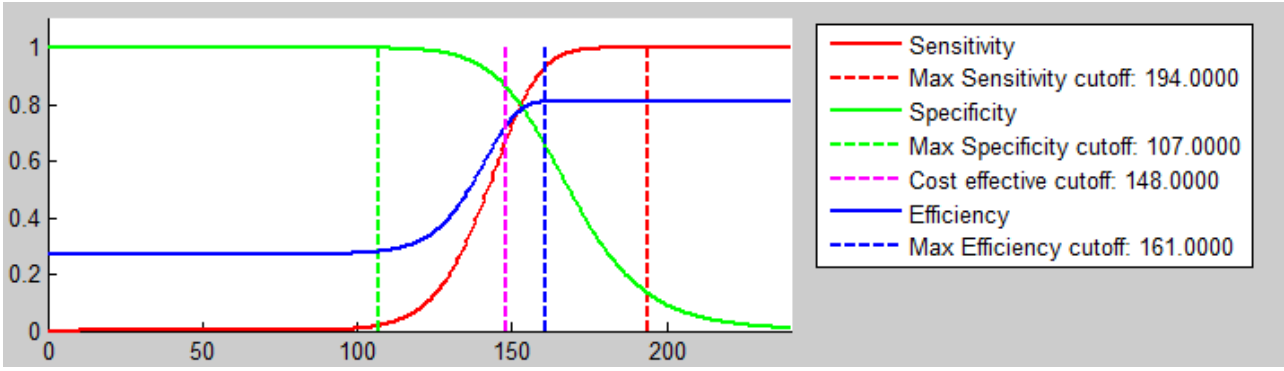

Fig. 5(b) Graphical Representation of parameters

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IV. CONCLUSION AND FUTURE WORK

This system has proposed a system which can accurately extract the vein pattern from a palm-dorsa image and uses it for personal authentication. Region of interest has been extracted from the given palm-dorsa image which contains noise (like skin texture or hair), non-uniform illumination and low local contrast. Such problems have been handled in this paper. The genuine vein pattern has been extracted from this pre-processed image by a multi-algorithm fusion strategy. Effectiveness of the proposed fusion strategy has mainly resulted from the usage of both local and global

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thresholding. Extensive experiments are carried out to evaluate the effectiveness of the dorsal finger vein pattern approach with 3 different feature extraction schemes

The system can accurately extract the vein pattern from a palm-dorsa images and uses it for personal authentication. The system can give promising and accurate extraction of feature of dorsal vein (width, minutiae, and shape feature) which will be useful for proper and accurate and robust authentication of a person

D. **FUTURE SCOPE**

1. As here NIR image of fingers are used the problem of uneven illumination could be possible which can cause ineffective authentication. The accuracy can be increase by using more advanced and accurate acquisition systems or camera sensors.
2. The reliability of a system can be increased if this vein patterns authentication system collaborate with many other existing biometric traits like iris,fingerprint,DNA etc

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