Human Identification Protocol using Finger Vein Images

Sukhjeet Kaur,Sandeep Singh

Abstract— Finger Vein recognition is advanced form of biometric technique that is used to identify a person from finger image. An image of a finger captured under infrared light contains not only the vein pattern but also irregular shadows produced by the various thicknesses of the finger bones and muscles. The captured image of a finger have different vein patterns, also have various widths and brightnesses that changes depending on amount of blood temperature, physical conditions, etc. To robustly extract the precise details of the depicted veins, we have combined Repeated line tracking and a method of calculating local maximum curvatures in cross-sectional profiles of a vein image known as maximum curvature with segmentation. This method can extract veins in small segments without being affected by the fluctuations in vein width, temperature and brightness, so its pattern matching is highly accurate. The proposed method extracts the finger-vein pattern from the unclear image by using Repeated line tracking and Maximum curvature with segmentation. Finally the finger vein is searched and matched with previously saved finger vein image database on the basis of different parameters like MSE, PSNR and average accuracy. By the use of this technique the value of accuracy up to 99.500 %.

Keywords: Finger Vein recognition, Repeated Line tracking, Maximum Curvature and Segmentation.

1 Introduction

Personal identification technology is used in wide range of systems including area-access control, PC login, and e-commerce. Biometrics is the statistical measurement of human physiological or behavioral traits. Biometric techniques for personal identification have been attracting attention recently because conventional means such as keys, passwords, and PIN numbers have problems in terms of theft, loss etc.

In the area of biometric identification, security and convenience of the system are important [1]. In particular, the systems require high accuracy and high response times. Biometric methods based on the pattern of fingerprints [9–11], facial features [18], the iris [14], the voice [15] or the veins on the back of the hand [12]. However, these methods don't necessarily ensure complete confidentiality because the features used in these methods are exposed outside the human body. These methods can therefore be susceptible to forgery.

To solve this problem, A biometric system using patterns of veins within a finger, that is, patterns inside the human body [2,3] is proposed. In this system, an infrared light is transmitted through the finger. A finger is placed between the infrared light source and camera. As hemoglobin in the blood absorbs the infrared light, the pattern of veins in Finger captured as a pattern of shadows. The captured images contain vein patterns but also irregular shading and noise. The shading is produced by the varying thickness of finger bones and muscles. Therefore, regions in which the veins are and are not sharply visible exist in a single image. There are two key factors that are cited for the preference of finger-vein biometrics. First, the finger veins are hidden structures; it is very 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 high security capabilities as it can also ensure aliveness in the presented fingers during the imaging.

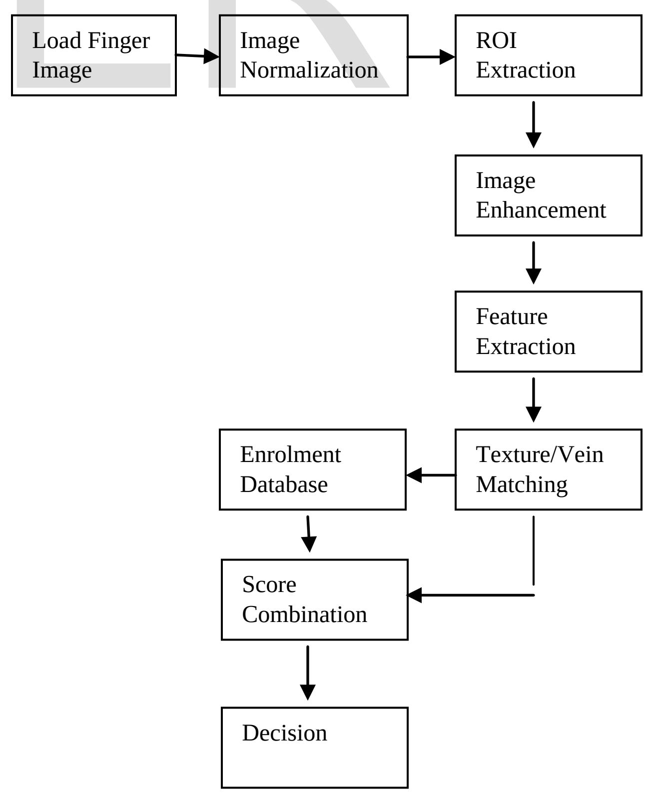

Fig. 1: Block diagram for personal identification using finger-vein imaging.

The acquired finger-vein are first subjected to preprocessing steps, which automatically extract the region-of-interest images while minimizing the translational and rotational variations. The enhanced and normalized ROI images are employed to extract features and then generate matching scores similar with a conventional biometrics system. The combined matching scores are employed to authenticate the user.

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

Finger vein has various advantages which makes this technique more efficient as compare to other techniques. These are as followings:

Accuracy: In biometric technique the rate of false user acceptance and true user rejection are very less as compared with other techniques. Because of these features this technique is reliable for security purpose [4]. In this technique FRR and FAR are very less so overall accuracy of system is very high [3]. These features shows size of data is low and increase speed of system which makes fast authentification process and portability. Fast in speed: Vein pattern matching is very fast because only extracted features are matched. So this method makes fast. Security: Vein pattern is internal body feature of human so it is not affected by external conditions and not possible to forge. The outer factors like as humidity and temperature [6].

Small in size: In Finger vein authentification technique the devices which acquire image are very small in size and not expensive.

I. RELATED WORK

The finger-vein patterns are quite unique, even in the case of identical twins and 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; 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 anti-spoofing capabilities as it can also ensure aliveness in the presented fingers during the imaging.

Personal identification using finger-vein patterns has invited a lot of research interest [1]–[9], and currently, several commercial products have been available for civilian applications [24]. The extraction of finger-vein patterns can be improved with the use of local maximum curvature across the vein images. Lee and Park [10] have proposed Restoration method of skin scattering blurred vein image for finger vein recognition in which the restoration of finger-vein images using a point spread function. The authors suggest slight improvement in the performance for the vein identification using such restored finger images. Finger-vein network exploitation can be roughly classified into four main classes, namely line tracking methods [13, 14], threshold-based methods [8, 9, and 15], curvature-based methods [10, 15] and transformation based methods [16, 17]. Kumar, A. et al. [1] developed and investigated two new score-level combinations, i.e., holistic and nonlinear fusion, and comparatively evaluate them with more popular score-level fusion approaches to ascertain their effectiveness in the proposed system. The proposed system simultaneously acquires the finger-vein and low-resolution fingerprint images and combines these two evidences using a novel score-level combination strategy. The proposed technique increases the results and resultant value of finger vein authentification method. Yang's, J. et al. [2] developed a technique using enhancement signal for enhancement of finger vein image and improve the incorporating directional decomposition. Yu, P. et al. [3] developed a method which captures whole image of hand by using image acquiring device digital image capturing camera. Wan, D. et al. [4] developed density based map model and polynomial model for texture of finger identifications. Thai, L. H. et al. [5] researched a new standardized fingerprint model for finger print. Conventional methods such as the connection of emphasized edge lines [6], and ridge line following for minutiae detection in grayscale fingerprint images [11], matched filter [3] and morphological [4] methods can extract patterns easily if the width of veins are constant. However, these methods cannot extract veins that are narrower/wider than the assumed widths, which lower the accuracy of the personal identification.

We propose a method that solves these problems by checking the curvature of the image profiles and emphasizing only the centerlines of veins. Miura *et al.* [5] have improved the performance for the vein identification using a repeated line tracking algorithm. The method is based on repeated line tracking which starts at random positions. Local dark lines are identified, and line tracking is done by moving along the lines, pixel by pixel. When a dark line is not detectable, a new tracking operation starts at another random position. All the dark lines in the image can be tracked by repeatedly executing these line tracking operations. Finally, the loci of the lines overlap and the pattern of finger veins is obtained. As the parts of the dark lines are tracked again and again in the repeated operations, they are increasingly highlighted. Although noise may also be tracked, noise is focused to a smaller degree than the dark lines. This makes line extraction robust. Our method of detecting the maximum curvature positions is tough against temporal variations in vein width and brightness. The positions are connected point to point with each other, and finally the vein pattern is obtained.

II. FINGER VEIN IMAGE PREPROSSING

Finger vein image is acquired when an infrared light ray falls on finger and shadow of finger is generated. Since these infrared light rays are absorbed intensively by the hemoglobin in the blood of finger vein. This process scattered by other finger blood vessels [10]. There are various points which create effect or on clarity of finger vein images like as strength of finger and texture part of each person are unique. The location of finger, image acquiring component and overall performance of finger vein acquiring system plays important role. If image quality is very dull then images can create mismatched or false authentification output and this problem makes this technique time consumed preprocessing and complicated feature extraction. The acquired finger vein images contain noise with some rotational and translational variations resulting from noised or unconstraint images. In this process shows image have more detailed background area with noise. To remove noise or detail of image various operations are performed. After performing operations feature points are extracted.

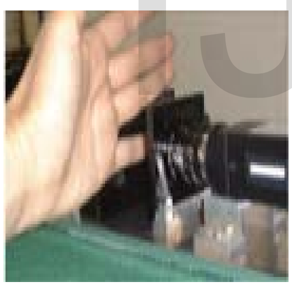

Figure:2 Acquiring finger-vein image by LED device [9]

The main purpose of new technique reduces previous problems and increase efficiency. The Sequence of algorithms used as follows:-

Normalization: In the first step, normalization method is used. The basic purpose of Normalization is to change the range of pixel intensity value. Binarization is a method of transforming grayscale. For edge detection Sobel edge detector is applied.

$$M = \frac{1}{M * N} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} (I(i, j))$$

$$\text{VAR} = \frac{1}{M * N} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \left(I(i, j) - M(I^2) \right) \quad \text{....3.1}$$

Region of Interest: When image is acquired, it contains very large detailed image or extra part of image. The unwanted area of image can be eliminated by selecting the useful area which is called ROI.

$$\sum \frac{(a_i \times I_i)}{A} \quad \text{.... 3.2}$$

$I_i =$ Intensity value of pixel with non zero intersected area

$a_i =$ Intersected area of pixel

A = Total area of vein image

Image Enhancement: For image Enhancement, histogram integrates pixel's intensity. Then objective of acquired image enhancement is to increase image visibility.

Finally output image represents features more clearly as compared to input image. Therefore, the average gray level of each sub blocks is calculated as following [1]:

$$I = \left\{ \frac{\sum_{\forall (x,y) \in B} B(x, y)}{\|M\|}, \|M\| > 0 \right.$$
$$M = \{\forall (x, y) \in B, B(x, y) \neq I_{bg}\} \quad \text{.....3.3}$$

B = image sub block;

M = subset of B;

I^{bg} = background pixel intensity value;

|| || = cardinality operator that yields number of elements inside;

III. PROPOSED METHOD

Algorithm for identification process: The approach used in authentification process is based on obtain maximum features and produce useful results. In this authentification process by applying some techniques produce more accurate results than previous. The objective of this approach has two-phase: Firstly, Normalization and then find the useful region of area for performing further operations. Secondly apply enhancement and then obtain maximum curvature with Segmentation. The Sequence of algorithms used as follows:-

Repeated Line tracking method: The repeated line tracking technique generates useful result in finger vein

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authentification [2]. The main idea behind repeated line tracking is to trace finger vein image by chosen directions like as in horizontal or vertical orientations. The line tracking method operates from pixel to pixel in the acquired image. The current operating pixel is called "tracking point" [6]. The tracking process moves pixel by pixel along valley or dark line. The angle between the cross section point and grey level called current operating tracking point.

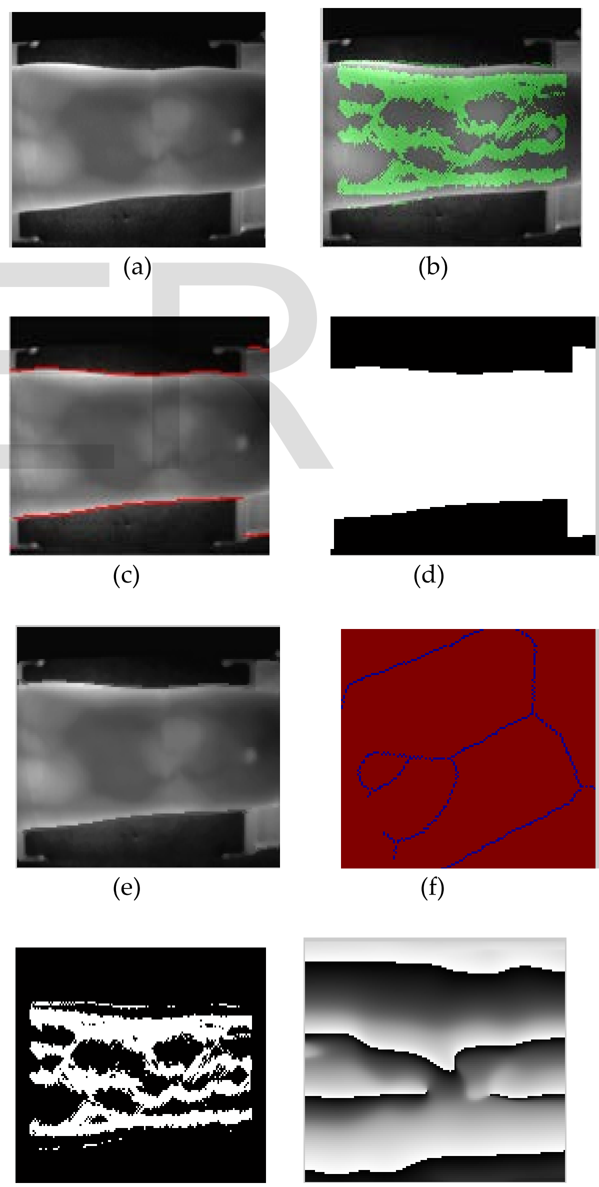
Maximum curvature and segmentation: Miura proposed a method that is based on calculating curvatures in cross-sectional profiles of a vein image. In this method, the centre lines of the veins can be extracted consistently without being affected by the imbalance in the width and brightness of the vein. This method overcomes the problems found in previous methods by checking the curvature of the image and focusing only the centre lines of veins. The centre lines are obtained by observing the positions where the curvatures of the cross-sectional profile are locally maximal. The algorithm details are described below.
Step 1: Calculation of the curvatures of profiles:
Step 2: Detection of the centres of veins:
Step 3: Assignment of scores to the centre positions
Step 4: Calculation of all the profiles
Step 5: Connection of vein centres

Step1- 4: To extract the centerline of veins with various widths and brightnesses, our method checks cross-sectional profiles of a finger-vein image. The cross-sectional profile of a vein looks like a dark patch because the vein is darker than the surrounding area. To find the vein pattern across an entire image, All the profiles in a direction are analyzed. To obtain the vein pattern spreading in all directions, all the profiles in four directions are also analyzed. The directions used are horizontal, vertical, and the two oblique directions intersecting the horizontal and vertical at 45degree. Thus, all the centers points of the veins are detected by calculating the local maximum curvatures.

Step 5: To connect the centers of veins and eliminate noise, the following filtering operation is conducted.
First, two neighboring pixels on the right side and two neighboring 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). Therefore, the value of (x, y) should be increased to connect the line. 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). Therefore, the value of (x, y) should be reduced to eliminate the noise.

The vein pattern is binarized by using a threshold. Pixels with smaller values than the threshold are described as parts of the background, and those with values greater than or equal to the threshold are labeled as parts of the vein region.

Matching with Database: After extracting features the score combination technique match and compare feature with database stored images. The proposed technique is implemented using MatLabR2013a. Finger vein image database consists of 200 images acquired from 160 volunteers (100 males and 60 females) from different age group. The result between previous and proposed method are compared on the basis of Better efficiency; Reduce MSE (Mean Square Error) and PSNR are shown in next section.



(a) (b) (c) (d) (e) (f) (g) (h)

Figure 3: Acquired image(a), Binarized image(b), Edge map(c), Vein ROI(d), Enhanced image(e), Segmented image(f), Output from repeated line tracking(g), Output from maximum curvature(h).

Finally, after performing these operations result analysis generate the useful or valid result

IV. RESULTS AND DISCUSSION

Proposed Technique Results are compared with previous technique results on the basis of various parameters like MSE, PSNR and Average Accuracy.

MSE:- Mean Square Error or amount of error is defined as difference between input image and matched image. In ideal condition if we take same input image as database image MSE will be zero but this is not possible as there will always be some noise present due to external or internal factors. Our proposed work reduces the effect of those internal and external factors and which can be seen be the below graph.

MSE is given by:-

$$mse = \sum((I_1 - I_2)\ /mxn\ )^2$$

Where I_1 is input image.

I_2 is database image.

mxn is total size of image.

Table 1: Comparison between previous and proposed MSE values

	MSE
Proposed method	184.9842
Repeated Line Tracking	219.1042
Even Gabor	195.6042
Even Gabor With Morphological	194.8742
AUTOMATIC TRIMAP Gen.	195.3442

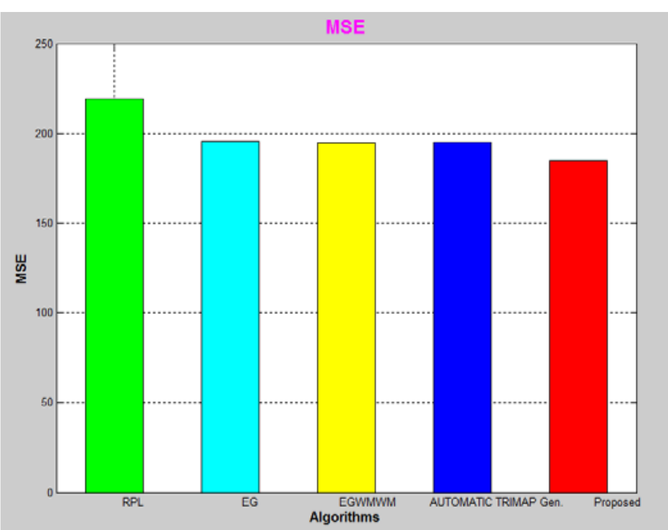


Figure: 4 Graph of MSE value between proposed and previous techniques.

PSNR :- Peak Signal to noise is ratio between maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.PSNR is inversely proportional to MSE.

PSNR is given as: $psnr = 10 * log_{10}(255/RMSE)^2$

where RMSE stands for root of mean sqaure error
255 is a constant ie., maximum pixel value.

Table 3:Comparison between previous and proposed MSE values

	PSNR(db)
Proposed method	49.4486
AUTOMATIC TRIMAP Gen.	25.3286
Repeated Line Tracking	14.8415
Even Gabor	24.4586
Even Gabor With Morphological	25.6316

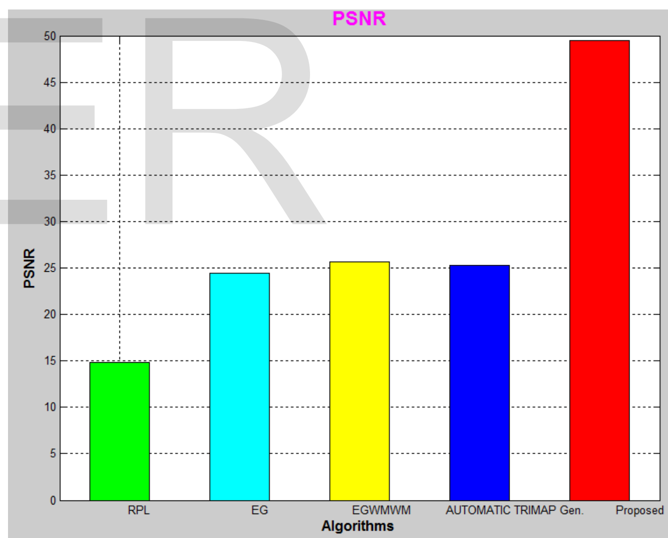


Figure:5 Graph of PSNR value between proposed and previous techniques.

Average Accuracy: - Average Accuracy is defined as the efficiency of any system. It is calculated by

Accuracy = (T.P + T.N)/ (T.P+T.N+F.P+F.N)*100

Where T.P and T.N are true positive and true negative.
And F.P and F.N are false positive and false negative.

Table 2: Comparison between previous and proposed accuracy values

	Average Accuracy(%)
Proposed method	99.5000
Automatic Trimap	73.5030
Repeated Line Tracking	64.9939
Even Gabor	74.5930
Even Gabor With Morphological	75.6930

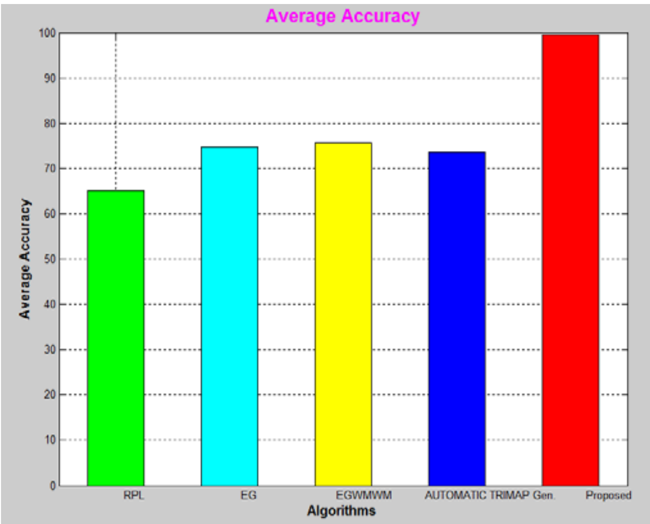


Figure: 6 Graph of Average accuracy value between proposed and previous techniques

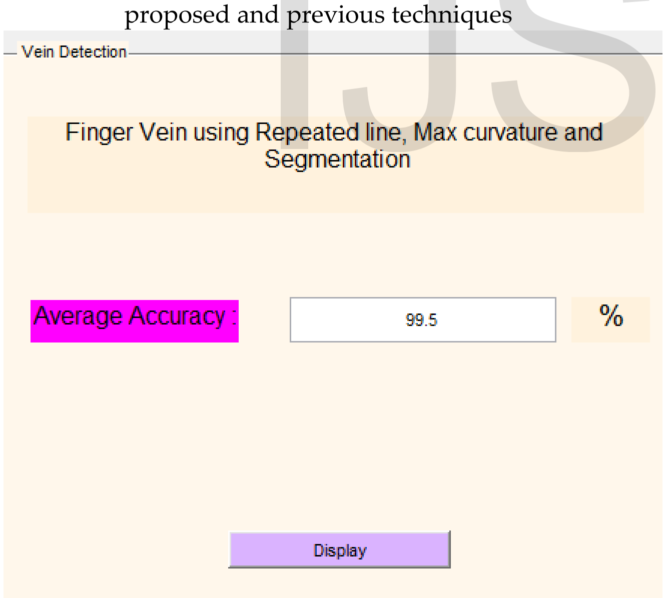


Figure: 7 average accuracy

The above figures shows the result of identity identification using finger vein images recognition by using repeated line tracking with maximum curvature and segmentation. This technique gives better result as compare to previous technique. By use this technique the value accuracy up to 99.500 %.

V. CONCLUSION

Finger vein recognition technique uses the unique method of finger veins images for authentification of person for higher level of correctness and privacy. Experimental results showed that our proposed Repeated Line Tracking, Segmentation and Maximum Curvature provides better result than matched filter, Gabor filter and repeated line tracking techniques independently. Shot detection according to dimension reduction approach needs more enhancements to represent results accurately to reduce complexity. At some point or images MSE values increased and PSNR values are decreased. Then overall accuracy of authentification technique effected. In further work apply some techniques which improve accuracy.

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