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A Finger Vein Recognition Technique for Authentication

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Abstract: Biometric is basically used for human identification using different feature of your personal nature. The features that can be used as biometric are face, palm print, voice, signature etc .There is requirement of high security as available biometric is not so much reliable and secure. So overcome this drawback Finger Vein Recognition system is used. Biometric are composite in term of time & space. Finger vein is more reliable for authentication. Finger Vein image is captured from living body only. They are complex to spoof .In this paper, image is embellish by concept of local histogram equalization which enhance the local contrast of an image. The features are take out from enhanced image using a combination of Frangi filter, FAST (Features from Accelerated Segment Test) algorithm and FREAK (Fast Retina Key point Descriptors).
Keywords: FAST algorithm, FREAK descriptors, Frangi filter, Image enhancement, Image pre-processing, local histogram equalization, Morphological opening.

1. INTRODUCTION

Personal identification is one of the major tasks in security system. Traditionally, password or Personal Identification Numbers (PINs) key etc are used in security system. But these authentations modes are easily forgotten. This problem is solving using biometric pattern. Biometrics is technology used to authenticate individuals by utilizing the uniqueness of his or her physiological and behavioural characteristic. So it is used as an alternative to the traditional authentation techniques. The commonly used biometric patterns are finger print, iris, face etc. But each of these biometric traits is that they are easily stolen by unauthorized persons. Here non-forgeable biometric pattern is considered .Finger Vein is an exceptional biometric pattern in terms of security and convenience.

Finger vein system can only apply on live body, because infrared camera can capture image only if haemoglobin is present in the body. A finger vein pattern is unmistakable and specific for every individual. Highly secure because vein pattern is sight inside the body and is difficult to replicate and reuse it. Finger vein recognition system can take low resolution images.

Here it has two main steps: image pre-processing and feature extraction. The objective of image pre-processing is to enhance some image features relevant for further processing task. After pre-processing, interesting details in the image are highlighted and noise is removed from the image. In pre-processing image quality and brightness changed by applying morphological operations and is enhanced based on the concept of local histogram equalization. Then appropriate features are extracted from the enhanced finger vein image by feature extraction techniques. The different techniques used in feature extraction are Frangi filter operation; FAST (Features from Accelerated Segment Test) algorithm and the concept of FREAK (Fast Retina Key point) descriptors. The extracted features are unique in every person and they can be used in the authentication stage [1]. This paper is managed as follows. In section III, problem identification and in section IV problem formulation. Then methodology adopted of finger-vein image pre-processing is discussed in section V, which include segmentation of ROI and image intensify. The feature extraction steps for the finger vein images are detailed in Section VI. Section VII complements the results with discussion. The key conclusions from this paper are summarized in section VIII.

II. Technique for finger vein recognition system: a state of the art

Finger Vein pattern recognition and improvement of a image is a wide and prominent field of research Large number of image processing techniques has also been used in recent past by many researchers for this. Reshma Rajan et.al [1] proposed a novel finger vein feature extraction techniques for authentication, the proposal had applied on the features of finger vein which is extracted from the enhanced vein images using a combinations of Frangi filter, FAST algorithm and FREAK descriptors.

M. Kono, H. Ueki et.al [2]In this paper finger vein patterns was improved by background reduction filter i.e low pass filter was used to minimize the background noises. But it filtered out some relevant information.

N. Miura et.al[3] enhanced the image of finger vein by repeated line tracking techniques, he took after a measurable methodology which was computationally serious

Kejun Wang et.al [4] proposed another technique for coordinating vein picture utilizing relative angles and distance. The relative separation and angle computation from a cross section topology is an exceptionally troublesome undertaking.

III. Problem identification

As the finger vein blood vessels are present inside the body so it is not easy for any camera to capture its image. To capture its high quality image a special device was developed which is not affected by ambient temperature. Generally, finger vein pattern images are captured based on the principles of light transmission or light reflection [10]. This is captured by the NIR (Near Infra-Red) camera, because NIR light can easily penetrate the bones of the finger irrespective of the thickness of bone. In this paper data base used have 156 images of different 17 subjects which took from casia.com

IV. PROBLEM FORMULATION

The bigger challenge in finger vein recognition and its Improvmentation is to extract its patterns from the low-contrast NIR (Near Infrared Image) images. Improvement of the vein patterns and extraction of their features from low contrast images is still a tough task The basic idea of this research work is to process (enhance) the finger vein images, extract its features and find out the accuracy by comparing different algorithms and techniques. The tools and algorithms of MATLAB R2014a is used. Image enhancement is done by the use of Local Histogram Algorithm on the pre-processed image of the database (NIR images).After this feature extraction process is done on the enhanced images with the help of, combination of Frangi filter, FAST algorithm and FREAK discriminator.

At the end the research comes to the important phase i.e. verification and accuracy calculation. This is being done with the help of Machine Learning's (Supervised Learning algorithm) Discriminant analysis. The accuracy is mentioned verified after comparing with various techniques of Supervised Learning Algorithm. After comparison with other techniques it has been observed that Discriminant Analysis gives more accurate result than others.

V. Methodology adopted

The pre-processing steps (see Fig. 1) are applied on finger vein images that include: change in colour contrast , noise removal and smoothing of image.

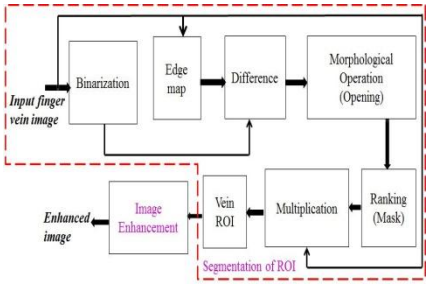


Fig.1. Block diagram of finger vein image pre processing [1]

V.1 *Segmentation of ROI*

The available input finger vein image contains finger portion and its background. The background contains no relevant information. So the finger portion is the region of interest (ROI). For analysis this ROI, first the finger vein image is converted to binary using a selected threshold value. Threshold value is calculated by standard deviation. Due to unlabelled illumination, some unwanted portions of background are connected to the required finger regions. Then morphological operation called opening is applied in the subtracted image. But the image contains extra bounded regions other than the required region. It calculate the threshold value and edges can be detect by thresholding and highlighted regions are labelled in the image. By applying histogram, the largest highlighted object in the image was extracted that resembles the ROI mask. Fig. 2 shows the steps that accurately segment the ROI mask.

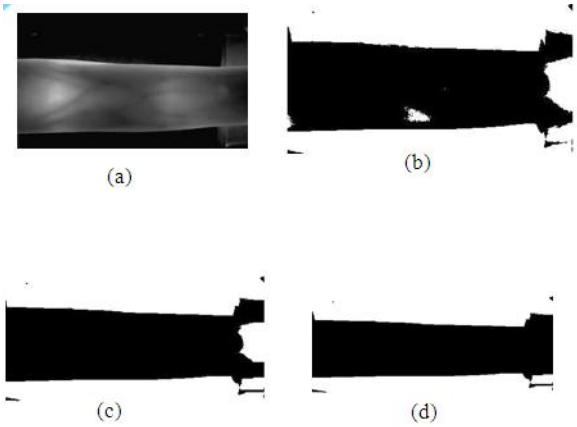


Fig 2:(a) Input finger vein image.(b) Binarized input finger vein image. (c) Image after morphological opening. (d) Image after complete noise removal

V.2 *Image Enhancement*

After segmentation some noise is present in our image .Here
we remove noise by morphology technique .we can remove by erosion and opening method. Now some portion of image is unfilled and unlabelled. After this image filling and label smoothing can be done. The pre processed image is multiply with original grey image. So required ROI gets after cropping. Cropping can be done by remove some row from top and remove some row from bottom. After this Brightness can be improved by adapt histogram equalization for changing brightness reiterate. For doing so vein portion will be bright and surface area become low.

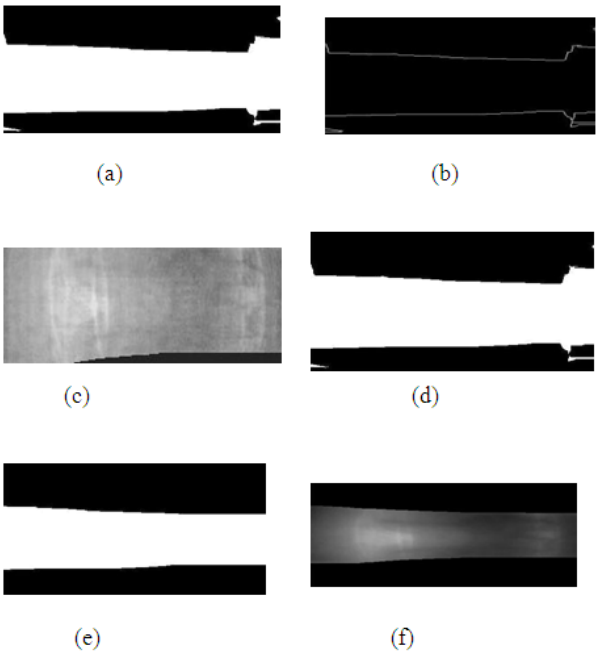


Fig 3:(a) Image after complete complementary operation (b).Image after edge detection (c). Image will be assessed using small subtraction edge image and morphing (d) Image after complete filtering, noise removal and subtraction. (e). Image after final ROI implementation (f) Reduced dimension of ROI

VI. Finger-vein feature extraction

The proposed block diagram of finger vein feature extraction is shown in Fig. 5. The feature map of finger vein image is extracted using Frangi filter. Then Features from Accelerated Segment Test (FAST) algorithm is used to find the point of interest from the finger vein feature map. For each point, a Fast Retina Key point (FREAK) descriptor invert the image and feature extract with change in features.

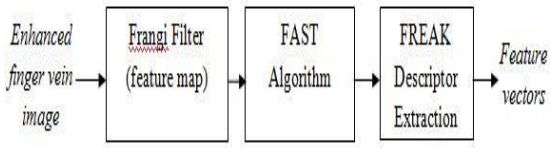


Fig 4: block diagram of Finger Vein feature extraction [1]

VI.1 *Frangi Filter*

The image processing method is based on the examination of Eigen values in Hessian matrix and is originally developed for blood vessel detection in medical images. It can also be used in some other areas, where line-like structures finding in the image is required. The Eigen values of the Hessian matrix are used to determine locally the likelihood of a blood vessel present in the region.

i) Analysis of the Eigen values of the Hessian matrix:

For a given pixel of the input image, a Hessian matrix is made from the image second order partial derivatives and is given by

$$H = \begin{bmatrix} \frac{\partial^2 I}{\partial x^2} & \frac{\partial^2 I}{\partial x \partial y} \\ \frac{\partial^2 I}{\partial y \partial x} & \frac{\partial^2 I}{\partial y^2} \end{bmatrix} \qquad [1]$$

where, I is the greyscale input image, H is the Hessian matrix and x & y are the coordinates of a pixel within I. The partial derivatives are calculated as pixel intensity differences in the neighbourhood of the pixel. The Hessian matrix describes the second order local image intensity variations around the selected pixel. For the obtained Hessian matrix its Eigen values λ_i are calculated. Using the resulting theoretical behaviour of Eigen values, the decision can be made if the analyzed pixel belongs to structure being searched

In general the method based on the Hessian Eigen value analysis capable of detecting not only tabular structure, but also blob-like and plate-like structure within the image. The Frangi filter is used to extract the vein features from the image.

VI.2. *FAST Algorithm*

The Features from Accelerated Segment Test (FAST) algorithm is used for the detection of corners (point of interest) in an image patch. After this algorithm matrix come with better corner point. Fig. 5 shows the twelve point segment test corner detection in an image patch

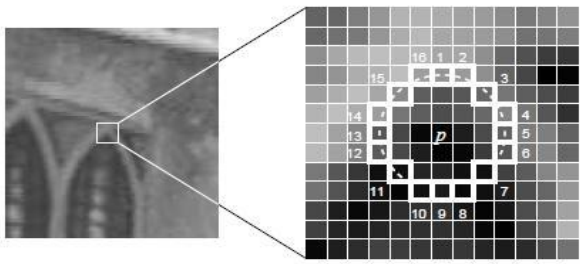


Fig 5: Twelve point segment test corner detection in an image patch [1]

Consider a candidate pixel p as given in Fig 5. Then choose a circle of sixteen pixels around the pixel p. Let Sp be the image intensity and t be the selected threshold value. In the circle of sixteen pixels, if there exists a set of l continuous pixels which are all brighter than Sp + t (Sp is the intensity of the candidate pixel), or all darker than Sp−t, the detector classifies p as a corner point, otherwise p cannot be a corner point. The l was selected as twelve. This segment test can then be applied to the remaining candidates by examining all pixels in the circle. The pixels used in the corner detection are highlighted as white-coloured squares. The dashed white line passing through twelve continuous pixels indicates the pixels which are brighter than p. i.e., their intensity values greater than Sp by a threshold value t.[1]

VI.3 *FREAK Descriptors*

The Fast Retina Key point (FREAK) descriptor is motivated by the human visual system or more specifically, the human retina. By comparing the image intensities, a binary string is calculated. FREAK filter invert the image and after this feature extracted. Then Feature come with descript of image. It also required less memory. Here, the topology of the retina is mimicked to design the FREAK descriptor

VII. RESULTS

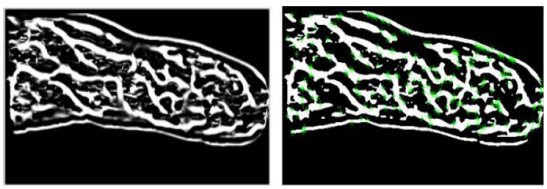
In this work, the pre processing and feature extraction of finger vein images was realized. Simulation is done in MATLAB [13]. The database used is take from [12]. The database contains finger vein and fingerprint images. But for this simulation only the finger vein images was used. Here it use 156 vein finger of different 17 subjects

VII.1*Finger-vein Image Pre processing*

The input finger-vein image (513 x 256) was given for pre processing steps. In pre processing, the first extract the ROI Then separated its background from object part. The input image was converted to binarization by selecting a threshold. .The binarized image was applied for background separation from ROI extraction. The next step of ROI extraction was edge detection. A Sobel edge detector was used to find the edges from the input image. Edge detection is a set of mathematical methods whose aim is at identifying points of a digital image, at which the image brightness changes sharply or, more formally, has discontinuities. The points on which the image brightness changes sharply are organized into a set of curved line segments termed as edges. Edge detection is a fundamental tool in image processing, machine and computer vision, particularly in the areas of feature detection and extraction. But the mask obtained after this processing was not same as original image since it contains so many connected noise in form of white pixels other than ROI region. So this connected noise other than the ROI region was eliminated by applying morphological operation called opening or erosion. Opening can be used to eliminate all noise pixels in regions that are too small to contain the structuring element. On the basis of this analysis, the largest connected object in the image was find out. This connected object accurately represented the ROI extracted processed image and was used to segment the ROI from the input finger vein image. This processed image was multiplied with the input grayscale image to obtain the ROI finger vein image. Now, the ROI of the finger vein image has been extracted and was used for further processing. The next step of image preprocessing is image enhancement. i.e., the image is enhanced for better visualization by cropping and brightness improvement. For that, the background of the vein structure was estimated. For background estimation, the resulting image was divided into subblocks Then the average gray level of each block was computed for background estimation and was resized for subtracting from ROI vein image. The resized average gray level image was subtracted from the ROI vein image. The local histogram equalization was applied to the resulting image for obtaining the final enhanced vein image. In order to do local histogram equalization, a mask size (10 × 20) was selected, which describes the size of the portion of the image to equalize at a time. The selected mask was placed above the image and then probability density of each value inside the mask was calculated. The cumulative distribution of each value was also
computed. Then the centre pixel value of the overlapping mask area was replaced by its Cumulative Distributive Function (CDF). Similarly, the computation was done for whole matrix by moving the mask. As the result, the finally obtained image was a locally enhanced one.

VII.2 *Finger-vein Feature Extraction*

The finger vein feature of image was extracted using Frangi filter. The resultant vein patterns were subjected to binarization for enhancing corner of vein patterns further.After applying this image come with better corner point. The output of this processing is shown in Fig. 6(a). Then corner points (point of interest) were obtained from the feature map by applying FAST algorithm.



(a) (b)

Fig 6: Finger vein feature extraction. (a) Feature map of finger vein image. (b) Corner points detected image [1]
The green colour shows in Fig. 6(b) are the detected corner points.

The FREAK descriptors of each of the corner points were calculated .FREAK filter invert the image and extract the feature .Features come with small descript of the image and it required less memory. Image can be recognizing with these features. Then the hamming distance between the corner points were computed and the correspondence corner points between the test image and the reference image was obtained after image registration as shown in Fig. 6, A denotes the test image and B denotes the reference image. 'o' indicates the correspondence points in the test image, which is in red colour and '+' indicates the correspondence points in the reference image, its colour is given as green. Then finger vein matching score was calculated and was used in the matching stage.

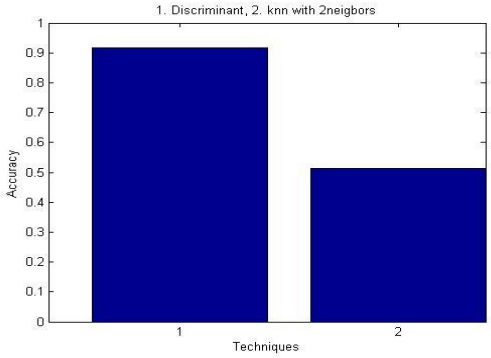


Fig 7: Recognition accuracy of two different methods

VIII. Conclusion and future directions

In this paper data base have 156 images of different 17 subjects [12].In this proposed work two algorithms Discriminant analysis and KNN is used for the accuracy or result calculation. This accuracy is calculated from human finger vein patterns features which have been extracted from the enhanced images in this work. The accuracy calculated from Discriminant analysis is 92.21% and by using KNN is 55.84%. By using above accuracy and comparing both the techniques and find the best method and conclude that Discriminant analysis is the best technique to calculate the accuracy of Finger Vein patterns features. So with the help of this research work we can develop a new biometric system which is more reliable. The finger vein pattern biometric system can be developed as the GUI (Graphical User interface) for mobile devices, laptops and tablets so that it can be used for any operating system for security purpose. This system can also be used in the ATM machine for the security of personal account. This system can also help in removing debit advantages of this technology are high degree of privacy and anti-spoofing capabilities. So it can be used in the field of authentication.

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