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Finger print and finger vein recognition using repeated line tracking and minutiae

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Abstract

Bio-Metric is a technological recognition system that aims to identify a person using physiological (like Iris, DNA matching finger vein, finger image etc.) and behavioral traits (like voice, signature, password, keystroke etc.). Since single modal biometric systems are facing numerous practical troubles such as noise in sensed data, non-universality, spoofing attacks and non-acceptable error rates. So, in order to overcome the above limitations, Multimodal biometric systems come into existence. In this research, a new approach is employed to improve the authentication. The system simultaneously acquires the finger vein using repeated line tracking and fingerprint image using minutiae and combines these two evidences using a decision level technique or feature level combination. At last SURF technique is used for matching the training and testing data.

Keywords: fingerprint, fingervein, repeated line tracking, minutiae, SURF

Introduction

Fingerprint Recognition

Fingerprint is a unique attribute of an individual which is used to identify and verify person identification as shown in Figure 1.1. These are used in forensic investigation for detecting the frauds for a longer duration.

Fig 1: Fingerprint image

A fingerprint consists of several ridges and furrows. Still, fingerprints are mainly identified by abnormal points which are found on ridges. These points are named as Minutiae, as shown in Figure 1.2. Minutiae are of many types, out of those one is known as termination, and the second one is known as bifurcation. Termination is a sudden finishing of a ridge whereas bifurcation is a point from where two other ridges appear.

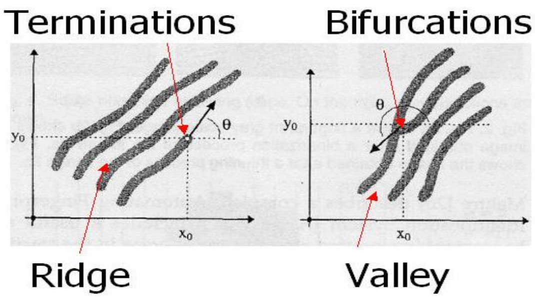

Fig 1.2: Minutiae (Termination and Bifurcation)

The fingerprint recognition is categorized into two domains i.e. fingerprint verification and identification. Two techniques are as follows:

- Automatic Finger image Authentication System (AFAS) [11].
- Automatic Finger image Identification System (AFIS).

a) Automatic Finger image Authentication System (AFAS)

AFAS identity is provided inform of input and a finger image, the outcome of this identity is true for matched and false for not matched. This process shows that whether the acquired image is matched with the particular person whose finger image is given in form of identity. As figure 1.3 shows, after acquiring image feature extractor extract features, compare with database and matcher matches features with database's stored image [11].

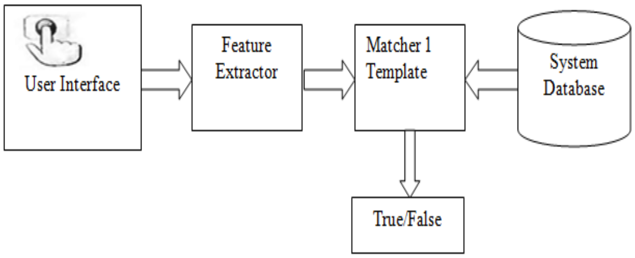

Fig 1.3: Verification of identity in AFAS [11]

b) Automatic Finger image Identification System (AFIS)

In AFIS fingerprint is given as input and then result shows log of person's identities that have provided the fingerprint image and a score indicating the resemblance among two images for each individual. Matcher matches multiple templates with database stored images [11]. By using N matching method, it saves time. This technique makes identification easy and gives partial identity detail to low the search space. The figure 1.4 shows that this method compares the input image with those images saved in database in both verification and identification for recognition purpose.

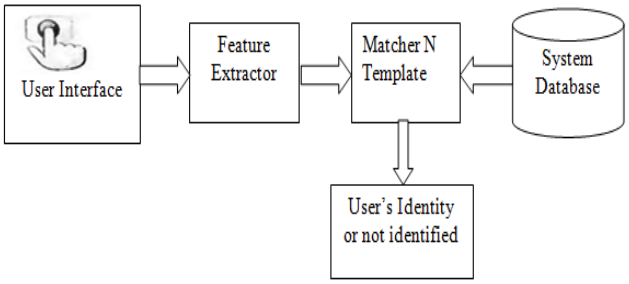

Fig 1.4: AFIS matches with N templates [11]

Finger Vein Image Preprocessing

Image of fingervein is acquired when an infrared light ray falls on finger and shadow of finger is generated. Since these infrared light rays are trapped in the blood of finger vein by the hemoglobin [12]. This process scattered by other blood vessels of finger [10]. There are various points which create effect or on clarity of 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 the quality of image is very dull then images can create mismatched or false authentication output and this problem makes this technique time consumed preprocessing and complicated feature extraction. The images of fingervein which are acquired contain noise with some turning and translational differences deriving 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.

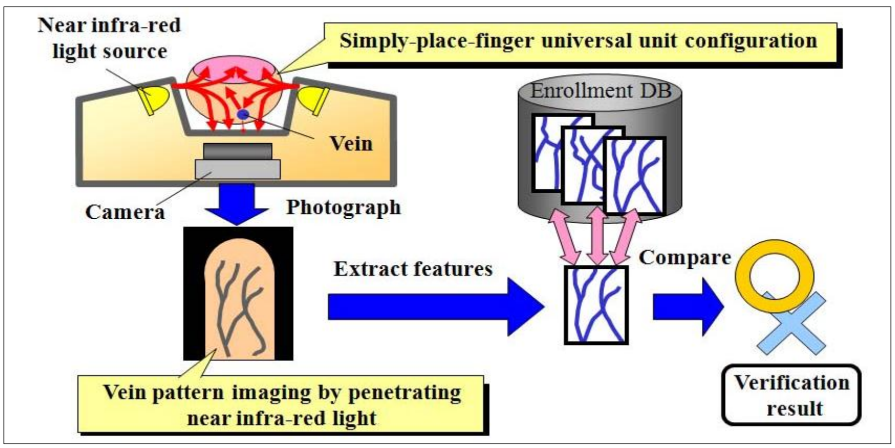

Fig 1.5: Principle of Finger Vein authentications

Therefore, images which are acquired are first subjected to preprocessing steps that include [12]

1) Segmentation of interested area.
2) Translation and orientation alignment [11].
3) Apply image enhancement for extracting particular features.

The block diagram in figure 1.6 shows steps for recognition of finger vein. The steps used for recognition process: acquiring finger vein image, finding region of interest, enhancement, extracting feature and the calculation of score combination. After acquiring fingervein image binarization operations are performed

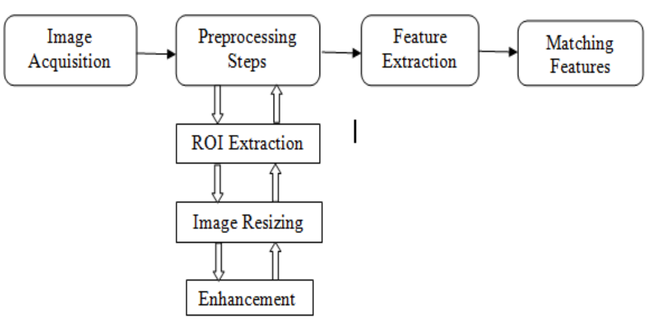

Fig 1.6: Recognition method for finger vein [12]

2. Literature Survey

Hui Ma *et al.* (2015) [15] proposed a novel based technique for authenticating the identity by applying multi-route detection method on both fingerprint and fingervein. Firstly, two classifiers were considered for fingerprint and finger vein image correspondingly. Then the third classifier was made by concatenating the feature vectors which were extracted from the first step and the final outcome was obtained when the three classifiers were fused and then recognition results at the decision level were calculated.

Masmoudi, A. D. *et al.* (2013) [28] represents multimodal biometric identification for recognition of finger print and finger vein, in which MonoLBP (Monogenic Local Binary Pattern) method was used. The original LBP (Local Binary Pattern) was integrated with the local phase and local surface type by the operator. Experimental results confirmed that a projected fusion obtained the brilliant identification performances in comparison to unimodal systems. The AUC of projected approach which was based on two modalities combination was very close to unity (0.93).

Kumar, A. *et al.* (2012) [21] proposed technique which is utilized for Identification of humans Using Images of Finger. The proposed technique increases the results and resultant value of authentication method of fingervein. The new researched technique generates method which simultaneously obtains both images of finger vein and finger print images which have low resolutions. The low resolution image of fingervein adds the characteristics of different needed features by utilizing a novel score-level combination strategy. The new researched technique determined various other different developed techniques of authentication techniques of finger vein. The new method indicates other different approaches and new features of resent developed technique. The usage of finger print images which have low resolution obtain by using acquiring devices and determined the matching features and performance of these type images. The new researched and research finds two different score level combinations. The holistic and thin images with nonlinear fusion are two score combination. Then compare these features or scores and finally determine these features with some needed score fusion level method for finding correct or effective results. The experiment results used in database stores 6264 images from 156 different subjects which depicts great increment in the performance. The authentication and recognition results are utilized in this technique. The research shows after acquiring both vein image of finger and texture of finger images then combine two main finger image features with scores of different finger features combining technique. The new techniques compare and evaluate previous techniques and shows accuracy of new technique.

Huang, B. *et al.* (2012) [14] represented a method, when posture of finger change by using posture change method and correct the image of finger vein identification method. The recent technique researched which showed that when posture of image changes at finger image acquisition time. According to this technique six different kind of posture of finger moves and determine the effect on image. The new researched technique used to redevelop three dimensional (3D) images with normalization finger images from two dimensional (2D) images. This technique is applied for mapping finger area from two dimensional images into reconstructed two dimensional image coordinates, so this technique is utilized to reduce illumination which creates by six type change in posture. This technique uses three methods for extracting the feature and 5070 images of finger vein for vein identification. The resultant images show correct and effective result images. The new 3D normalized method used to remove image influence effect which generate after changes of posture. The three methods are utilized for extraction of features and manipulations are performed on database stored image of finger vein.

Nandini, C. *et al.* (2012) [32] researched a method for individual identification using images finger vein. This research shows feature extraction methods from hand vein patterns. In this, an innovative approach was projected for the purpose of extraction of features from pattern of the dorsal hand vein. The length and the angle at the bifurcation points were chosen as the important features for this system. The matching algorithm used was K-nearest point matching neighbor and Hough transform. These two algorithms show unique points of each finger and makes system correctness. This technique makes 90% accuracy of system. The projected methodology was examined on 20 person's of dataset of dorsal hand vein images. The beginning point and bifurcation points were used as feature of image.

Feng, J. *et al.* (2011) [6] projected a technique for Fingerprint Reconstruction. From Minutiae a based technique algorithm is used. Algorithm of reconstruction of fingerprint had been proposed which generate the gray scale image after reconstructing the phase image. This algorithm gave the reconstructed fingerprint having few false minutiae. Image of fingerprint was designated as phase image comprising of continuous as well as spiral phase. From minutiae, an algorithm was projected to rebuild the continuous phase from it. The success rate of proposed algorithm was evaluated keeping in mind the type-I attack i.e the original fingerprint was matched with the reconstructed fingerprint as well as type-II attack i.e the reconstructed fingerprint was matched against dissimilar impressions of unique fingerprint. This algorithm reconstruct image by removing noise and detail of image. From minutiae, continuous phase was reconstructed using this algorithm and shows success rates. Finally match manipulated image with database stored images and shows original fingerprint image and showed success rates. Finally match manipulated image with database stored images and shows original fingerprint image.

Park, K. R. *et al.* (2011) [34] developed a technique for extracting the feature in which three steps were used and then compared with previous techniques. This research presented the advantages and contributions compared to previous works. Firstly the local information of vein was extracted without having regions of fingervein being segmented using LBP (Local Binary Pattern).Secondly, Wavelet transform was used for the extraction of global information of fingervein. At Last, SVM (Support Vector Machine) combined the score values of first step i.e LBP and second step i.e Wavelet transform. As experimental results, the EER (Equal Error Rate) was 0.011% and 98.2ms was the total time of processing. This extraction was performed without any division or segmentations.

Turroni, F. *et al.* (2011) [42] projected a technique in improvement of Orientation Extraction and implementation of Fingerprint. This technique developed and test several different technique. The novel plethora with different internal variants, particular arranged, benchmark method, framework of FVC which is available for further manipulations. The research shows that optimizations of all parameters and both pre and post processing operations increase accuracy of dull or blur fingerprint quality. At the end of stage, final implementation shows that a novel adaptive technique that exploit accuracy after selecting of local analysis based and global based learning technique. Thus achieve the overall accurate performance on a challenging dataset. The latest technique shows several methods. In this technique parameters are optimized. These operations improve accuracy, correctness and quality of finger texture image.

Yangs, J. *et al.* (2010) [45] developed a method for enhancement of image of finger vein and improve the incorporating directional decomposition. The proposed technique shows the enhancement of network and segmentation of image of Finger-vein. The paper described an important method in which patterns of fingervein of person was obtained for manipulation attention. The light or rays attenuation can create great impact in finger image. The rays of light sometimes decrease the brightness or clarity of vein image. Due to this degradation vein features are not clear. Novel method for venous region enhancement and finger-vein network segmentation was used so as to get ideal networks of finger-vein. Firstly, a process focuses on removal of scattering, directional filtering and suppressing the information of false vein in order to have an effective enhancement of images of finger vein. Then Segmentation approach based on matting was presented so as to have an automated network of fingervein extraction by considering the variations of veins in intensity and diameter. Then the useful results are obtained for correctness of new researched technique.The background detail is removed after subtraction of image and this process eliminate noise by using filtering technique. The enhancement technique generates finer and more enhanced images.

Thai, L. H. *et al.* (2010) [41] researched a new way for identification of fingerprint by applying standardized fingerprint model. According to this technique some particular standardized model of fingerprint is used to synthesize the template image of fingerprints. This technique showed that operations of pre-processing were performed. Then transformation among different templates and set parameters, synthesize the fingerprint image. Finally noise reduced.According to new standardized model, firstly operations related to pre-processing were performed. Then apply transformation and set parameters of image. By using this method noise in the image get reduced. Finally fingerprint images compare with dataset stored images and match to illustrate the correctness of new method.

Aybar, E. *et al.* (2010) [2] developed a method which make use of Sobel edge detector and it is used to discover edges and using edge function find derivative of edges. It is one of the popular method of edge detection. edge.m is a function which is found in the image toolbox. In this function, Sobel scheme make use of the derivative approximation in order to locate the edges. So, edges are returned at only the points which are having the image gradient in maximum size. The matrices 3x 3 dimension of both horizontal as well vertical gradient is used in the operations of detecting an edge. In this, a function is designed to locate edges with the matrices 5×5 dimensions. The return edge point's shows both horizontal as well as vertical gradient matrices which have 3×3 dimensions. The resulting image shows all main points or whole image which is small in size.

Yang, J. *et al.* (2010) [45] This shows main causes which generate problems for localization and extracted feature in image of finger vein. An intrinsic physical characteristic of individual fingers is utilized to focus the ROI (Region of Interest) of images of vein and also removing unclear information of vein imagery. Results of experiments depict the favorable performance of the planned algorithm for the identification of human vein. This method explains technique to get ROI (region of interest) and eliminate extra detail of image vein. The filters are utilized to remove noise and finally results shows performance of new researched technique.

Mahri, N. *et al.* (2010) [27] developed a method for reducing the complexity of system for identification of finger vein. In this, initially, POC (Phase-Only Correlation) function was implemented at matching stage. Evaluation of projected algorithm depicted that it produced an efficient performance with EER(Equal Error Rate) was 0.9803% and 0.6362s was the total time of processing even though vein images had been acquired from device having lower cost. Thus, The results of this new proposed algorithm shows vein image which acquired by cheap device generate correct or efficient performance.

Hong, J. *et al.* (2010) [16] researched new algorithm image mosaic which lied on SURF (Speeded up Robust Feature). Features were extracted using SURF operator and matched with database. SURF operator had an intense strength and superior performance for features extraction instead of conventional SIFT operator. The features which were extracted got matched by the fast bidirectional matching. Then outliers were eliminated by using a RANSAC algorithm and transformation matrix was obtained between images. Finally by using a multi-band blending algorithm images got stitched. This algorithm overcomes the flaws of the conventional method of image mosaic which were susceptible to objects which were different in scale and moving. The result of experiments depicted that the technique with strong robustness operated at a faster rate with effectiveness. This technique compares image bidirectional and generates result fastely. This technique removes boundary pixels and generate matrix of image pixels. The algorithm improves performance, time and overcomes illumination which generate by moving objects.

Yu, H. *et al.* (2009) [48] developed a Minutiae based technique. By applying this technique features of minutiae are extracted.The minutiae features extraction algorithm: the (CPCA) Column Principal Component Analysis and LDFT (Line Discrete Fourier Transform) methods of reducing the feature. These two methods can correctly reduce the template size with 94% of compression rate. After feature reduction method, the fast feature matching means feature based minutiae matching technique. This technique shows the correctness and performance by using spectral minutiae of image of fingerprint identification technique. This high speed operation makes the system suitable for operating in complicated environment or geographical level like police patrolling which significantly reduce the time for matching. This technique make use of two reduction algorithms i.e CPCA (Column Principal Component Analysis) and LDFTF (Line Discrete Fourier Transform feature) reductions. These two algorithms reduce size or detail of image up to 94%. This technique generates result fast.

Yu, P. *et al.* (2009) [49] this paper described a way which captures whole image of hand by using image acquiring device digital image capturing camera. Operations of pre-processing are carried out on image. After performing pre-processing operations image is divided into segments and extract region. In this paper, different images of fingerprint are used for manipulation or performing some preprocessing operations on an entire image of hand by obtaining some acquisition devices. The methods of pre-processing include key point location, finger image segmentation and fingerprint region extraction. Firstly, main features containing some fingertip features, ridges and valleys. These main feature points called key points. The key points are situated at contour part of hand image. Then, middle finger part is selected. After cropping the hand image, main feature points are obtain. At final step, middle finger image is cropped so as to extract the feature by using knuckle texture. The finger images which have low resolution, PCA (Principle Component Analysis) and LDA (Linear Discriminant Analysis) are two linear ways which are applied for extracting the fingerprint features. The results obtained from different manipulations are saved in database of 86 hands prints. The 10 types of impressions of each hand are used and different ways create effective results. The two main methods first PCA (Principle Component Analysis) and second is LDA (Linear Discriminant Analysis) are applied for extraction of feature of fingerprints.

Mulyono, D. *et al.* (2008) [30] developed a method for noise removal which was produced by the light transmission. In this, web camera captured the finger image under the infrared transmission of light which consists of pattern vein along with the various shade formed by finger thickness, muscles, bones, and networks of tissue surrounding the vein. So firstly the process was introduced to upgrade the quality of captured image whose quality was degraded due to noise or light, then the technique of adaptive threshold was used to segment patterns of vein and they were matched with the help of improved template matching. Results of experiments depicted that by applying a suitable process quality of degraded vein image could be improved and could achieve up to 100% identification ac-curacy.

Wan, D. *et al.* (2006) [43] developed a method for texture of finger identifications by applying density based map model and polynomial model. In this technique polynomial model applied for density mapping of images of fingerprint and some parameters are applied for fingerprint feature representation. Then for the purpose of matching, density information is used with small storage cost.In this technique fusion at decision level was applied for combining density map match with feature of minutiae used matching. Then final outcome of this technique shows correct and better performance by using multiple minutiae as compare to single minutiae used matching.These two models used to appropriate the mapping of density of fingerprint images. These methods generate results by applying minutiae used feature matching technique. Then results were better in this technique as compared to previous techniques.

Kulkarni, J. V. *et al.* (2005) [20] researched a technique which based on orientation of finger vein image alignment. In this, orientation and alignment of finger vein technique was projected. Area around the core point had been employed as an area of interest for determining the orientation feature map. ROC (receiver operating characteristics) determined an algorithm performance. Two databases were used. Firstly, database of University of Bologna observed FAR (False Acceptance Rate) was~0%, GAR (Genuine Acceptance Rate) observed was ~78%. And for second database i.e FVC2002 database, FAR was ~0% and observed GAR was 75%. Proposed algorithm yields better GAR was better in projected algorithm and FAR was lower with less computational complexity. This technique showed core points were used for finger feature extraction. Finally performance was measured along with the comparison with previous techniques. The novel method reduced GAR value was ~93% and FAR was ~18%.

Miura, N. *et al.* (2004) [29] projected a finger vein technique for person recognition in which image was captured when light falls on finger. The image which was captured with the help of infrared light consists of patterns of vein along with the shading which was irregular produced due to finger bones and muscles thickness. This method made use of line tracking technique which helps in extracting the pattern from finger vein image which was not clear. The results of experiments depicted that it attains the robust extracted pattern and 0.0145% was the EER (Equal Error Rate) in individual identification.

3. Present Work

The methodology of the projected work for both the fingerprint and fingervein system is explained as shown in figure 3.1

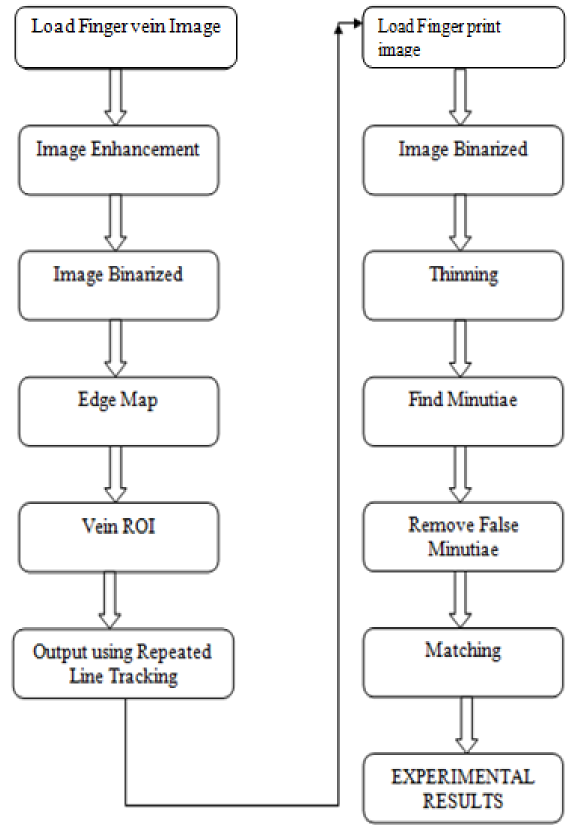

Fig 3.1: Proposed Fingerprint and Fingervein Recognition System

Repeated Line Tracking

This technique generates useful outcome in authentication of finger vein [2]. The key thought behind repeated line tracking is to trace image of finger vein by chosen directions like as in horizontal or vertical orientations. After choosing directions, repeated line tracking scheme is applied and applied ample number of times. This technique extracted the maximum features [8].

Figure 3.2 depicts that an image of finger vein appears in form of valley. This method operates from pixel in the image. “Tracking point” is known as the current operating pixel [6]. The tracking process involves the movement of pixel by pixel beside valley or dark line. The angle formed among the cross section point and grey level is called current operating point of tracking

Tracking of dark lines is shown in Figure 3.2 and example of cross section. The present tracking point (xc, yc) and cross sectional profile are relation which shows spatial relationship. In upper direction p shows neighbor pixels of present tracking point. The s-p-t is cross sectional points called valley. The dark line represents the present point of tracking. The θi shows the valley depth by darken lines. Pixel p shows current point of tracking that moves along the closest pixel according to grey level direction.

When dark line is not current point of tracking and new operation of tracking begins from other pixel called fresh tracking point. A vein in cross section area is valley. The shading of image changes the valley depth and valleys detectable. This dark line tracking provide efficient method for identification of finger vein.

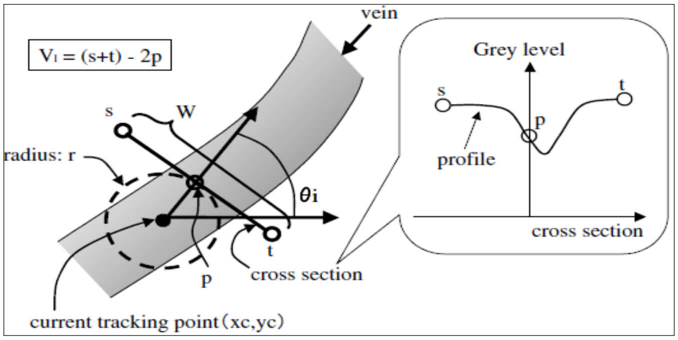

Fig 3.2: Tracking of darken lines [12]

When method of tracking is performed on whole vein image then in sequence various positions are determined so tracking process of line is conducted across vein image. If a single line tracking operation is manipulated, single vein is tracked in image

In dark line tracking, dark lines are tracked with repeated operations of tracking of line. This technique generates accurate extraction of pattern for finger vein. Pixels of image are partitioned into set of array. This array is called locus space [2]. The number of pixels in captured image shows the image size. Numerous operations on which each pixel of image is current point of tracking. These pixels are represented in matrix or array form.

Minutiae

Three-stage approach i.e. preprocessing, minutia extraction and post processing are used in order to implement a minutiae extractor as shown in Figure 3.3.

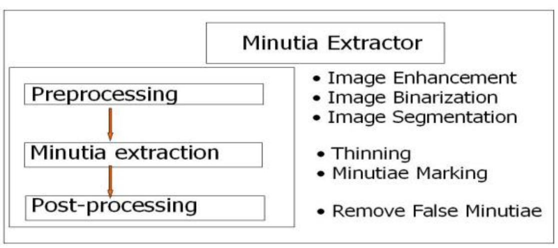

Fig 3.3: Minutia Extractor

In preprocessing, Histogram Equalization and Fourier Transform is used for enhancement of image [9]. And then binarization of an image is done using the locally adaptive threshold method [12].

In minutia extraction, three thinning algorithms [12, 2] are tested.

In post processing, false minutia is removed by developing the rigorous algorithm [12, 1].

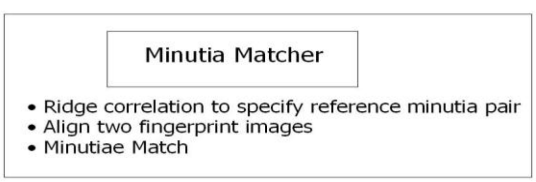

Fig 3.4: Minutia Matcher

Two minutiae are chosen randomly as a pair of minutiae by the minutiae matcher as a reference. After that, connected ridges are matched firstly and then images of two fingerprint gets aligned after the well matching of ridges[1].further the matching is performed for the rest of minutiae's as shown in Figure 3.4.

Speeded up Robust Features (SURF Features)

It is applied for matching in this system due to its robust detector of local feature that can further be utilized in computer vision tasks like object recognition or 3D reconstruction. At distinct locations like corners of image, blobs as well as T-junctions in image, Interest points are chosen. The repeatability which depicts the detector reliability is an important asset of interest point detector. It is utilized for matching in the recognition system; here it has its use to locate the critical points which help in matching the images more accurately. It contains interest point descriptor as well as detector. Interest points are located by the detector in the image, whereas the descriptor is responsible for describing interest point's features along with the feature vectors construction of the interest points.

Proposed Algorithm

Step 1: Firstly the primary point is determined for line tracking as well as moving-direction attribute. The line tracking start point is $(x_{s,}\ y_s)$,a pair of uniform random numbers selected from $R_{f.}$ The initial value of the existing tracking (x_c,y_c) point is $(x_{s,}\ y_s)$.After that, the moving –direction attribute D_{lr}, D_{ud} is determined. $D_{lr,}D_{ud}$ are the parameters that prevent the point of tracking from following a path with excessive curvature. $D_{lr,}$ and D_{ud} are independently determined as follows:-

$$D_{lr} = \begin{cases} (1,0)\ (\text{if } R_{nd}(2) < 1) \\ (-1,0)\ (\text{otherwise}) \end{cases}$$

$$D_{ud} = \begin{cases} (0,1)\ (\text{if } R_{nd}(2) < 1) \\ (0,-1)\ (\text{otherwise}) \end{cases}$$

Where R_{nd} (n) is a standardized random numeral from 0 to n.

Step 2: Direction of dark-line and tracking point movement is determined.

Step 2-1: T_c is the table of locus-position which needs to be initialized. T_c i.e. table of locus –position that stores the position of movement of tracking point. The table is initialized in this step.

Step 2-2: N_c which is a pixels set is determined to which the existing tracking point can move.

Step 2-3: Direction of the dark-line is detected close to the recent tracking point.

Step 2-4: Locus is registered in the T_c which is a table of locus-position and tracking point movement.

Step 2-5: Repeated execution of steps 2-2 to 2-4. If V_i is positive, move to step 2-2; if V_i is negative or zero, leave step 2 and move to step 3, since dark line does not have $(x_{c,}y_c)$.

Step 3: Numerous points are updated in locus space which has been tracked.

Step 4: Repeated execution of steps from 1 to 3.

Step 5: Acquisition of the veins patterns from the locus space

Step 6: Every minutia is designated by Dirac pulse in the domain of spatial. For $m_i(x, y)$, fourier transform is given by:

$$F\{m_i\,(x, y)\} = \exp\big(-j(w_x x_i) + (w_i y_i)\big)$$

and the location-based spectral minutiae is shown by

$$M_L\big(w_x, w_y\big) = \sum_{i=1}^{Z} \exp\big(-j(w_x x_i + w_y y_i)\big)$$

Step 7: End

4. Results and Discussion

The effectiveness and accuracy of any work done could only be judged by its results and outputs generated. Depending on the system type used and its applications, many parameters are there, basis on which a system is approved or rejected. This effectiveness could be measured only when the system runs on different datasets and values of different parameters are recorded and further used to deduce the net results.

Parameters Used For Evaluation

As this work depends on matching, system efficiency is evaluated by calculating the following parameters:

a) FAR(False Acceptance Rate)
b) FRR(False Rejection Rate)
c) EER(Equal Error Rate)
d) GAR(Genuine Acceptance Rate) or Accuracy

Accuracy

The EER contains FAR (False Acceptance Rate) and FRR (False Rejection Rate). FAR describes probability of false match generates and FRR shows the variations of false rejection ratio. FAR (False acceptance ratio) shows fake signature acceptance. It is ratio that shows the count of fake user that the system accept in reference to the total count of comparisons made in this technique [13].

FAR = [Number of fake users accepted /Number of forgeries tested]*100

i) FRR (False Rejection Rate)

It is defined as the ratio of number of cases rejected between numbers of cases tested. It shows the system probability failing to identify a comparison between acquired image and matched image with database stored image. FRR calculates the average of correct inputs that incorrectly rejected [13].

FRR = [Number of genuine rejected/ Number of genuine tested] *100

FRR = False Rejection Rate.

ii) Genuine Acceptance Ratio (GAR)

Total accuracy of biometric system is measured by this [13]. The formula used for calculating GAR is:

GAR=1-FRR

If comparing two different systems, the system with the highest GAR rate is opted to be the most accurate.

$$\text{Accuracy}=\frac{\text{FAR+FRR}}{\text{Total number of test}}$$

$$\text{Accuracy}=\frac{FAR+1-GAR}{Total\ number\ of\ test}$$

Accuracy in our work is calculated 99.9775%

Values Generated For Different Parameters

After the recognition phase final outcomes are displayed as described in the below snapshots

Table 4.1: Comparison of result with previous work for first image

S. No.	Previous Method (Minutiae)	Proposed Method (Repeated line tracking& minutiae)
1. EER	15.59	14.64
2. Accuracy	99.70	99.97

The EER (Error Equal Rate) is reduced and Accuracy rate is higher in the implemented work as compare to the previous working methods.

Evaluation and Comparison

The above tables show the Accuracy values comparisons. Accuracy Value of proposed system is 99.97%.

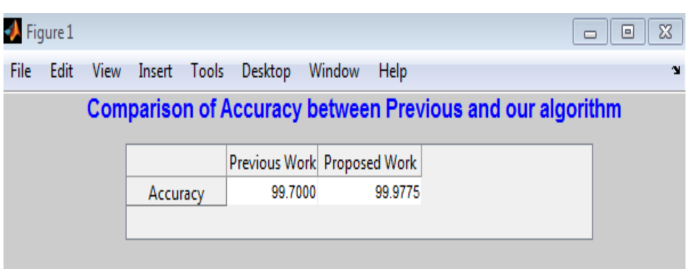

Fig 4.1: Comparison of Accuracy between previous and proposed algorithm

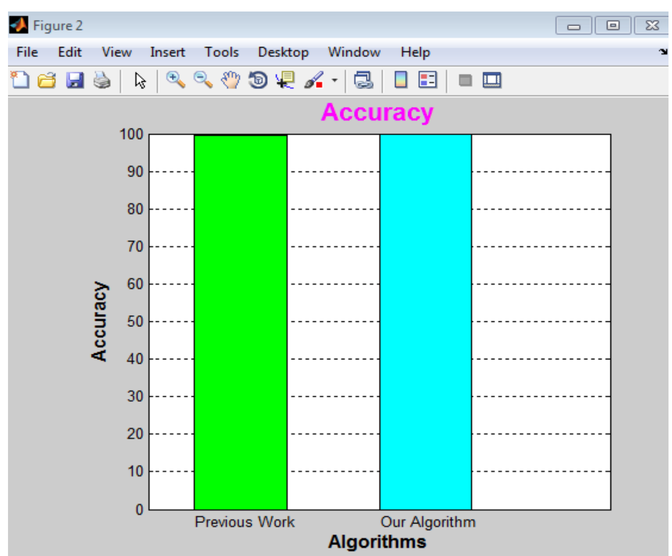

Fig 4.2: Graph of comparison of Accuracy between pervious work and proposed work

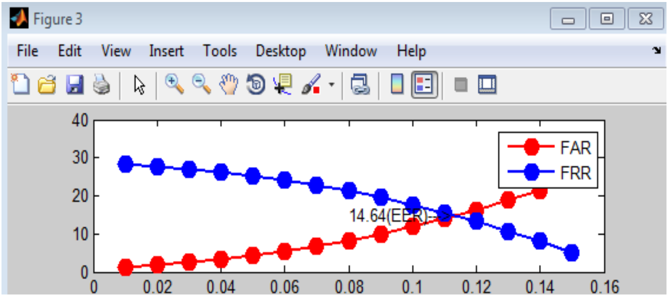

Fig 4.3: Graph of FAR (False Acceptance Rate) and FRR (False Rejection Rate)

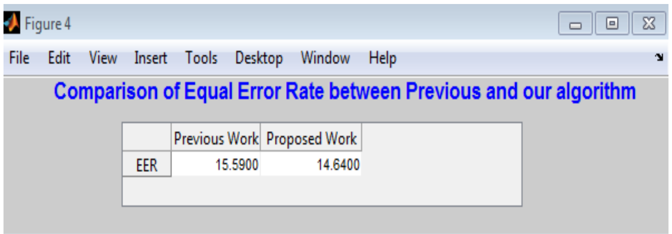

Fig 4.4: Comparison of EER between pervious work and proposed work

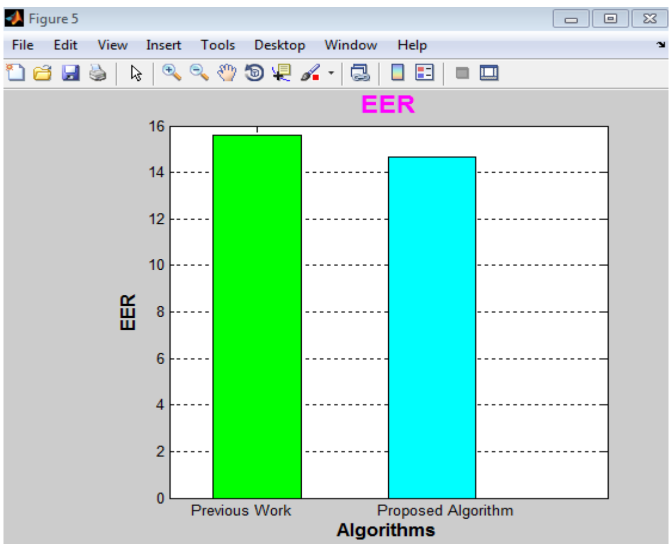

Fig 4.5: Graph of comparison of EER between previous and proposed algorithm

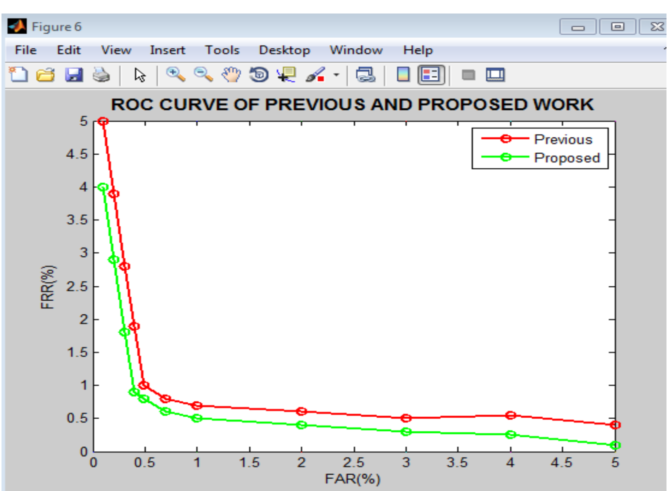

Fig 4.6: Graph of comparison of ROC between pervious work and proposed work

5. Conclusion & future scope

In this, a multi modal recognition system is proposed which support finger vein along with fingerprint image using different techniques. The contributions of the work are enumerated as follows:

- First, a recognition measure is presented at feature level by fusing fingerprint and finger vein images.
- Secondly, the proposed takes full lead of information from different modalities. We adopted repeated line tracking method in finger vein image and minutiae-based method in fingerprint image.
- Third, we proved the validity of the projected system by comparing its performance with that of the previous work lied on the parameters like FRR.FAR and finally ROC curve is being generated. It has been noticed that the suggested system is more accurate ie 99.9775 % in its recognition as compared to the previous work i.e 99.7000% and EER for proposed system is 14.6400 % in comparison to previous work i.e 15.5900 %.

The result shows the better improvement from the previous result by using SURF feature. Effective outcome have been generated in this work. As a result, this work has shown to be an encouraging progress to fingerprint-fingervein based human identification.

The proposed work has done feature extraction with repeated line tracking in case of finger vein and minutiae for finger print image with SURF matching algorithm. Still a lot of explorations is possible in this field.

For future work, a system can be design which will be able to acquire the fingerprint and fingervein almost simultaneously followed by building a larger fusion image database to further boost up the performance and efficiency of a proposed multi modal system. Also, EER (Equal Error Rate) can further be minimized by proposing some more effficient algorithm so as to develop a system which will be free from forgery attacks.

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