Authentication System through Hand Veins and Knuckle Shape

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ABSTRACT

Biometrics is a way that identifies people with the help of physical human features. There are many ways of biometric identification and recognition systems such as fingerprints, face, iris and veins etc. However, these conventional methods have some problems with respect of performance and convenience. Every human hand has unique veins patterns. Hand veins based recognition is most feasible than all of other conventional methods especially because of its easy acquisition process and also difficult to forge hand vein pattern. The proposed sytem 'Dorsal Hand Veins Biometric Recognition System Using Hybrid Algorithms is one of the biometric techniques which introduces the design and implementation of a system using QFT and Butterwort high pass filter algorithms is used to selecting ROI and to estimate the image ROI, edge and morphological filtering for future extraction. These algorithms give good accuracy for the specified region of interest. The first step is to pre-process the image and find the knuckle profile using grayscale thresholding and image inversion. Image segmentation is performed on the image to get the significant edges. The image is then processed to remove noise, and using morphological operations the vein pattern is signified. The region of interest is then cropped and a 1-pixel thick skeleton pattern is obtained using image thinning which is used as a feature for matching and recognition. Triangulation method using Delaunay's principle is used to find vein bifurcations and endings using local thresholding. Finally triplets are matched and used as a parameter to compare image stored in database and input image. The proposed results have been improved when compared to the existing results. The proposed system have been developed in MATLAB 2013a version.

Keywords: - Digital Image Processing, Biometric, Dorsal Hand Veins, Vein recognition.

1. INTRODUCTION

The word biometric is derived from the combination of two Greek words "bio" means "life" and "metrics "means "measure" [1]. Biometric systems are of two types, one behavioral that deals with the behavioral patterns or traits of human body like gait, typing style, handwriting, speaking and movement of body whereas second one is Physiological that deals with the physical appearance of the human body parts doesn't matters either these part are external or internal. For example, hand veins, retina, iris, palm, finger, foot, face and etc. As security has become more valuable in different fields especially in highly protocol cases, that's why these biometrics systems are taken into account because they are unique from human to human and provide far greater security and reliability than other systems. There are many methods that are designed in order to fulfill the security, reliability and high performance criteria by using human biometrics. The oldest technique among these systems is "Facial Recognition System" that was designed to identify a person in crowd. Other biometrics systems used for authentication are handwriting, veins, fingerprint, and voice and so on [2][3]. System that uses fingerprint for authentication and identification is used mostly due to low price and ease of use and identification [4]. People brought implementation closer to eye like Iris and Retina scan because they have better results than voice, handwriting, facial and finger print. One step forward to this people used human hand veins for identification process and so do we. Human veins pattern are unique to every human body and provide a good constraint to differentiate a person from others even in twins [5]. It is very easy to get the pattern of hand veins because hand veins absorb more light than other tissues and gives a prominent image that is enriched in information and easy to classify [3][5]. The vein structure's view depends on many factors such as: skin thickness, person's age, surrounding temperature and a physical activity done by the person and other surface conditions like warts, moles, injury scars, hairs etc [6]. Imaging technologies that are used to acquire images of hand veins are of two types: first one is Far-Infrared (FIR) technology that has spectrum ranges between 8-14 micrometer and effective in capturing the large veins on the back side of hand but it is very sensitive to surrounding conditions due to which it cannot results a good and information enriched image. Second technology is Near Infrared (NIR) technology that has a spectrum ranges from 700-1000 nanometer yielding better and information enriched and

stable images of veins present in palm, hands and wrist. NIR provides good images even in surrounding and body changes..

This paper deals first introduction part and 2nd chapter tells that existing system and 3rd chapter says proposed method 4th chapter shows results of existing and proposed method and 5th chapter gives conclusion of the paper

II. EXISTING SYSTEM

The existing system is based on the Triangulation method based on image processing like Acquisition of a database, Storage of database and Live Acquisition of image and comparing with Database, or comparing existing image in database with images in database.

Initially required users are authorized by training images by knuckle profile extraction, ROI extraction and feature extraction. Then the user is allowed to scan his dorsal hand from which the image is acquired using an NIR camera. Then the image is converted to grayscale and then Binarized using Otsu's Thresholding method which divides the image into Foreground and Background Pixels, thus assigning Pixels nearer to the black level as 0 and white level as 1, converting image to binary. This thresholding identifies minimum variance between these pixels to aptly identify them. Edge Detection is carried out on this image to get the final knuckle profile. This knuckle shape extracted from the acquired image can then be inverted as required for the ease of processing depending upon the 1 or 0 approach.

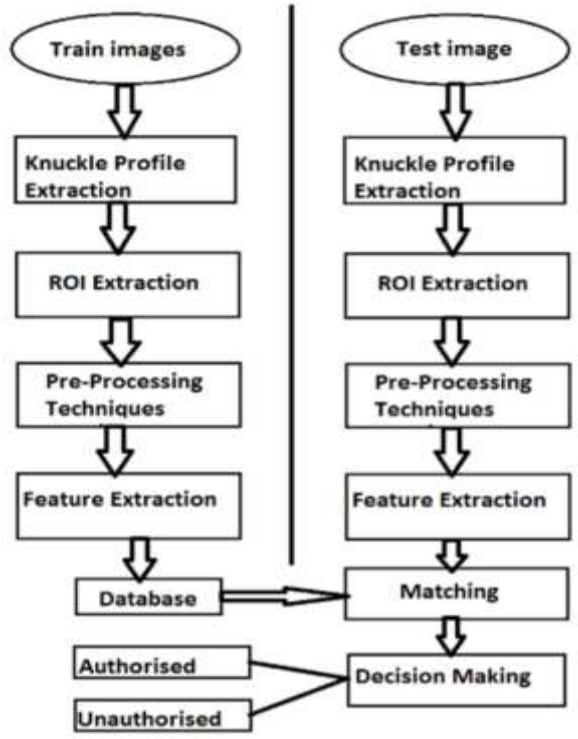

Figure 1: Block Diagram of Existing System

Then the Region of Interest Extraction is done and the image is cropped from the input image using adaptive cropping in MATLAB. After the necessary part (Part with main veins i.e. The one under the index, middle and ring finger) is cropped ,AHE(Adaptive Histogram Equalization) is performed to get a contrast stretched, even contrast image. This image is then morphologically thinned to get the vein patterns that are exactly in 1-pixel thick configuration, which reveal the necessary bifurcation and end points. The noise reduction techniques used are Median Filtering or LOG Filtering. This system uses Median Filtering to reduce the high freq. components.

From these, the triangulation is performed which extracts minutaes present in ROI. Delaunay's Triangulation is a method in which triplets are formed with respect the adjacent points in the given area and follows certain properties while forming them. Thus we create a 'Trained set' by training every image we have to store the Endpoint triplets and Bifurcation point triplets of each and every image in a matrix. Now the extracted image details are compared with the matrix in which we have stored the BPs and EPs of the trained images. The least Difference or Threshold is decided (Ideally should be '0'), and if an image within that threshold is found in comparison to the test image, then the test image is said to be an image from an Authorized User , else if no image is found within the threshold , then the comparison fails and the test image is said to be an Un-Authorized user.

III. PROPOSED SYSTEM

The training of the dataset remains same but the input image is processed in a different manner i.e., initially the hue, saturation and intensity components in the image are separated, then quaternion transform is applied. Further the image is processed by inverse quaternion transform and passed through Gaussian pyramid for image appropriate reconstruction. Then the thresholding and binarization are performed to convert the image into Gray scale. Then the Knuckle profile extraction, ROI extraction is performed. The thinned objects are removed by using a median filter to remove the high frequency components. Then the minuate extraction is performed i.e., bifurcation and end points are extracted. Now after Delaunay triangulation, the image is matched with existing database of users data and the decision of authorized or unauthorized user is taken based on the matching of matrices.

Also the parameters like accuracy, sensitivity, specificity, precision, recall, f measure and gmean are extracted for evaluating the performance of existing and proposed systems.

Accuracy: Accuracy refers to the closeness of a measured value to a standard or known value. Its Value must be high.

Precision: Precision refers to the closeness of two or more measurements to each other. Its value must be high.

Sensitivity: The sensitivity of a test is its ability to determine the authorized user correctly. Its value must be high.

Specificity: The specificity of a test is its ability to determine the authorized user correctly based on true negative or opposite cases. Its value must be low.

Recall is referred to as the true positive rate or sensitivity, and precision is also referred to as positive predictive value (PPV); other related measures used in classification include true negative rate and accuracy. Its value must be high.

f-measure is a measure of the test's accuracy in statistical context of binary classification. Its value must be high.

Gmean is the geometric mean is a type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). Its value must be minimum.

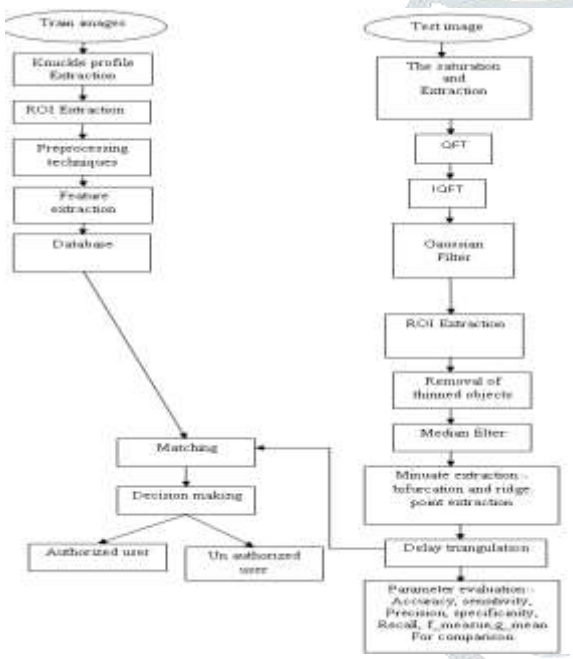

Figure 2: Proposed block diagram

Initially the input image is converted to a HIS image, then using pure quaternions, the image can be represented in quaternion form as follows:

$$f(n,m) = H(n,m)\mu_1 + S(n,m)\mu_2 + I(n,m)\mu_3$$

Where (n,m) is the location of each pixel.

H(n,m), S(n,m) and I(n,m) are the Hue, Saturation and Intensity components of the pixel, respectively. The choice of μ is arbitrary. The generalized complex operator used in the Quaternion Fourier Transform, $\mu_3 = \mu_1\mu_2$, $\mu_1 \perp \mu_2$, $\mu_2 \perp \mu_3, \mu_3 \perp \mu_1$. f(n,m) is represented in symplectic form as

$$f(n,m) = f_1(n,m) + f_2(n,m)\mu_2$$

$$f_1(n,m) = H(n,m)\mu_1$$

$$f_2(n,m) = S(n,m) + I(n,m)\mu_1$$

Then the Quaternion Fourier Transform can be calculated as

$$F(u,v) = F_1(u,v) + F_2(u,v)\mu_2$$

$$F(u,v) = \frac{1}{\sqrt{MN}} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} e^{-\mu_1 2\pi\left(\left(\frac{mv}{M}\right)+\left(\frac{nu}{N}\right)\right)} f_i(n,m)$$

For $i \in \{1,2\}$, $f_i(n,m)$is calculated by $f(n,m)$. The size of image is $M \times N$. $F(u,v)$ can be represented in polar coordinates as

$$F(u,v) = |F(u,v)|e^{\mu\phi(u,v)}$$

Where $\phi(u,v)$ is the phase spectrum and $|F(u,v)|$ is the amplitude.

The phase preserves the edge information. But its ability to highlight features is limited so the power of position information should be boosted further by using Butterworth high-pass filter (BHPF) with high-frequency-emphasis to make frequency information higher from amplitude spectrum. A 2-D BHPF of order n and cutoff frequency D0 is defined as

$$H(u,v) = \frac{1}{1 + [D_o/D(u,v)]^{2n}}$$

Where $D(u,v) = [(u - M/2)^2 + (v - N/2)^2]^{1/2}$ is the distance between a point (u,v) in the frequency domain and the center of the frequency rectangle. Do=4%of image size and n=1. The formulation of High Frequency

Emphasis filtering is defined as

$$H_e(u,v) = \delta H(u,v)$$

Where

$$\delta = K/\left(\sum_{m=0}^{M-1} \sum_{n=0}^{N-1} \left(SMAP(n,m)\right)^2/(M \times N)\right)$$

Through test, suitable K is 0.16. SMAP(n,m) is the initial saliency map with $\delta = 1$. The inverse Forier transform is given by

$$f_i(u,v) = \frac{1}{\sqrt{MN}} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} e^{\mu_1 2\pi\left(\left(\frac{mv}{M}\right)+\left(\frac{nu}{N}\right)\right)} F_i(n,m)$$

The output image can be constructed in the spatial domain by

$$f'(n,m) = x(n,m)\mu_1 + y(n,m)\mu_2 + z(n,m)\mu_3$$

$f'(n,m)$ is converted to grayscale to become initial saliency map.

A Gaussian pyramid is used to extract the ROI which is a technique used in final saliency map generating. Gaussian pyramid decomposition will generate a series of images in

which each image is a low-pass-filtered copy of its predecessor. The low-pass filtering is performed via convolution using a Gaussian filter kernel and down-sampling operator. Then we use a threshold to transform the saliency map into a binary mask, where ones refer to the ROIs. The final detection result (ROI) is generated by multiplying the mask in the original image. Then the remaining procedure is same as that of existing system. But due to the use of QFT, we obtain better extraction of features.

IV.SIMULATION RESULTS

1. Existing system

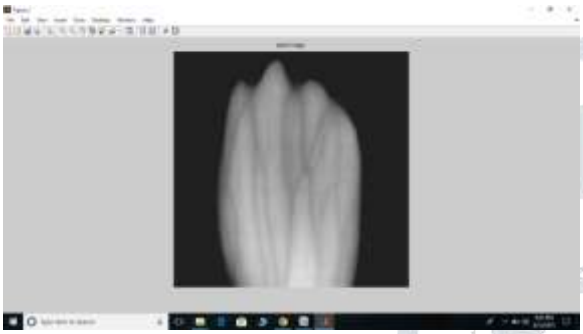

Figure 3 input image

In figure 3, Image can be acquired using an NIR camera and RGB image is converted into Grayscale image which is taken as Input Image.

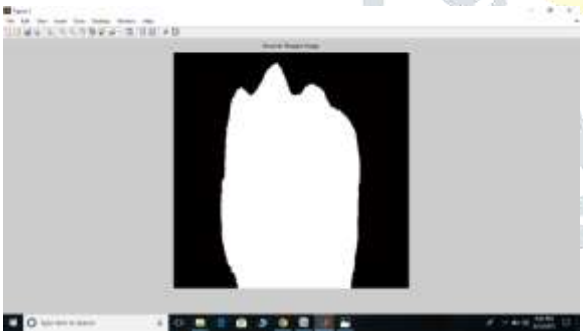

Figure 4 knuckle shape image

The knuckle shape image is in figure 4 then Binarized using Thresholding method. This thresholding divides image into two types of pixels. where the black level as 0 and white level as 1.

Figure 5 ROI image

In figure 5 shows the ROI Image in that ROI can be cropped from the input image now, using adaptive cropping in MATLAB.

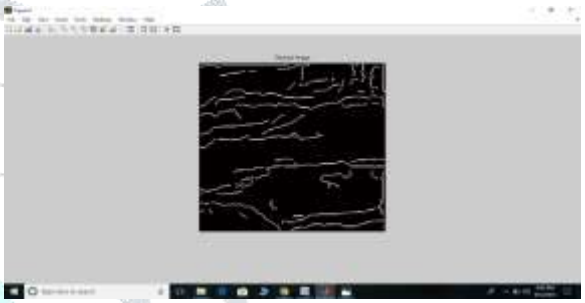

Figure 6 Thinned image

In figure 6 images is then morphologically thinned to get the vein patterns that are exactly in 1-pixel thick configuration.

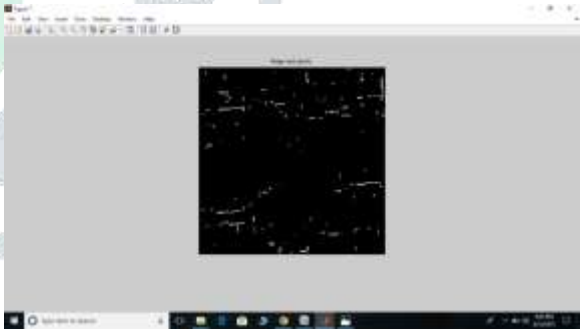

Figure 7 Ridge end points

In figure 7 is the vein has only one pixel around in its 8-neighbourhood, then that pixel is going to be an endpoint.

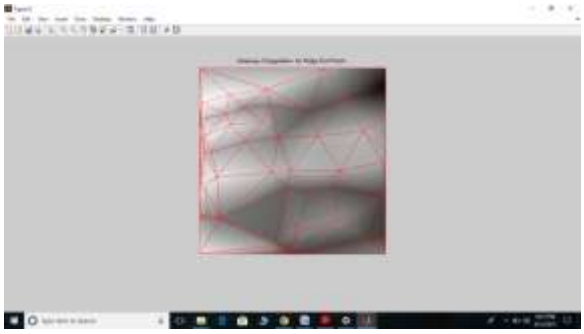

Figure 8 Delaunay's Triangulation and ridge end points

In figure 8 shows the end-points are obtained, the triangulation which is the most important part of the minutae extraction is carried out. Delaunay's Triangulation is a method in which triplets are formed with respect the end points in the given area.

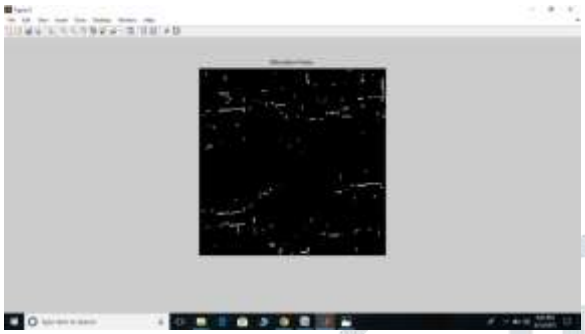

Figure 9 Bifurcation points

In figure 9 is the If a point on the vein has more than two pixels in its 8-neighbourhood, then that point is got to be a bifurcation points.

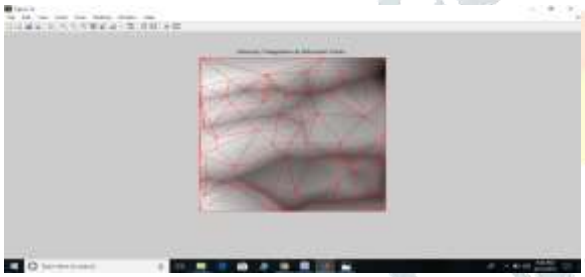

Figure 10 Delaunay's Triangulation and ridge end points

In figure 10shows the bifurcation points are obtained, the triangulation which is the most important part of the minutae extraction is carried out. Delaunay's Triangulation is a method in which triplets are formed with respect the adjacent points in the given area.

a) Authorized user

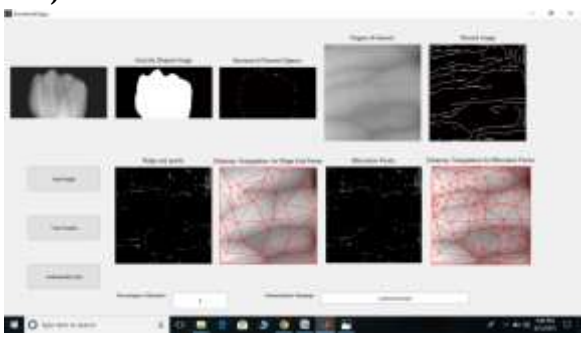

Figure 11 GUI Interface of Authorized User

The above figure shows the least Difference or Threshold is decided (Ideally should be '0'), and if an image within that threshold is found in comparison to the test image, then the test image is said to be an image from an Authorized User A specific GUI is built in MATLAB for the convenience of the user the specific program components are linked to the respective buttons.

b) Un-authorized user

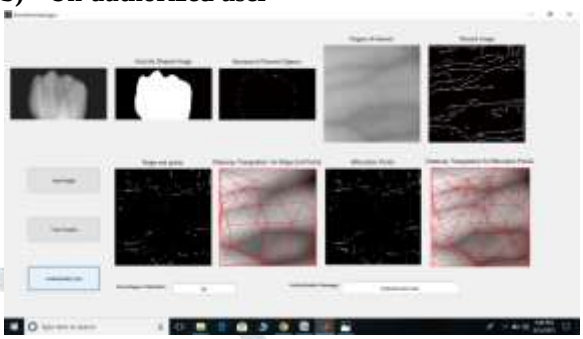

Figure 12 GUI Interface of Authorized User

The above figure shows the other one that is un-authorized which means that his template is not found in thes database.

2. Proposed results

a) Authorized user

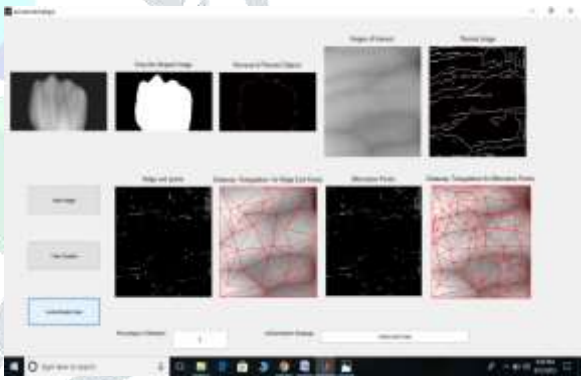

Figure 13 GUI Interface of Authorized User

The above figure shows the authorized user for the proposed method. In this performance level has been improved which is shown in the below level

b) Un-authorized user

Figure 14 GUI Interface of Un-Authorized User

The above figure shows the Un-authorized user for the proposed method. In this performance level has been improved which is shown in the below level

TABLE I Comparison parameters of existing and proposed methods

parameter	Existing	Proposed
Accuracy	0.2987	0.3456
Sensitivity	0.1245	0.4466
Specificity	0.6156	8.3762e-05
precision	0.3708	0.6044
f_measure	0.1864	0.5137
gmean	0.2768	0.0061

V CONCLUSION

Dorsal hand vein pattern offers high security and is reliable for identification, hence advantageous over other biometric systems. Accuracy, Non-contact as well as low maintenance system is achieved. Permanent Database as well as a system suitable for use in day to day applications is achieved. The proposed system got high accuracy level compared to than existing system.

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